

CENTRAL MASS. COMMUTER RAIL FEASIBILITY STUDY

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EXECUTIVE SUMMARY

Until 1971, commuter rail service was operated on the "Central Mass." rail line, branching from the Fitchburg commuter rail line at a connection in Waltham and extending to South Sudbury. Until 1965, this service had continued to Hudson, and until 1958 it had run to Berlin and Clinton. Except for a brief demonstration during the final weeks, Central Mass. service after 1959 consisted of one inbound A.M. peak and one outbound P.M. peak train. Freight service on the segment between Waltham and Hudson continued until 1980.

Because of population growth in the Central Mass. corridor since 1971, interest has recently been expressed in reinstituting service on the line. A provision of the Massachusetts state budget for fiscal year 1996 directed the Executive Office of Transportation and Construction to study the feasibility of reopening the Central Mass. as far as Route I-495. This study was performed by the Central Transportation Planning Staff in the spring of 1996.

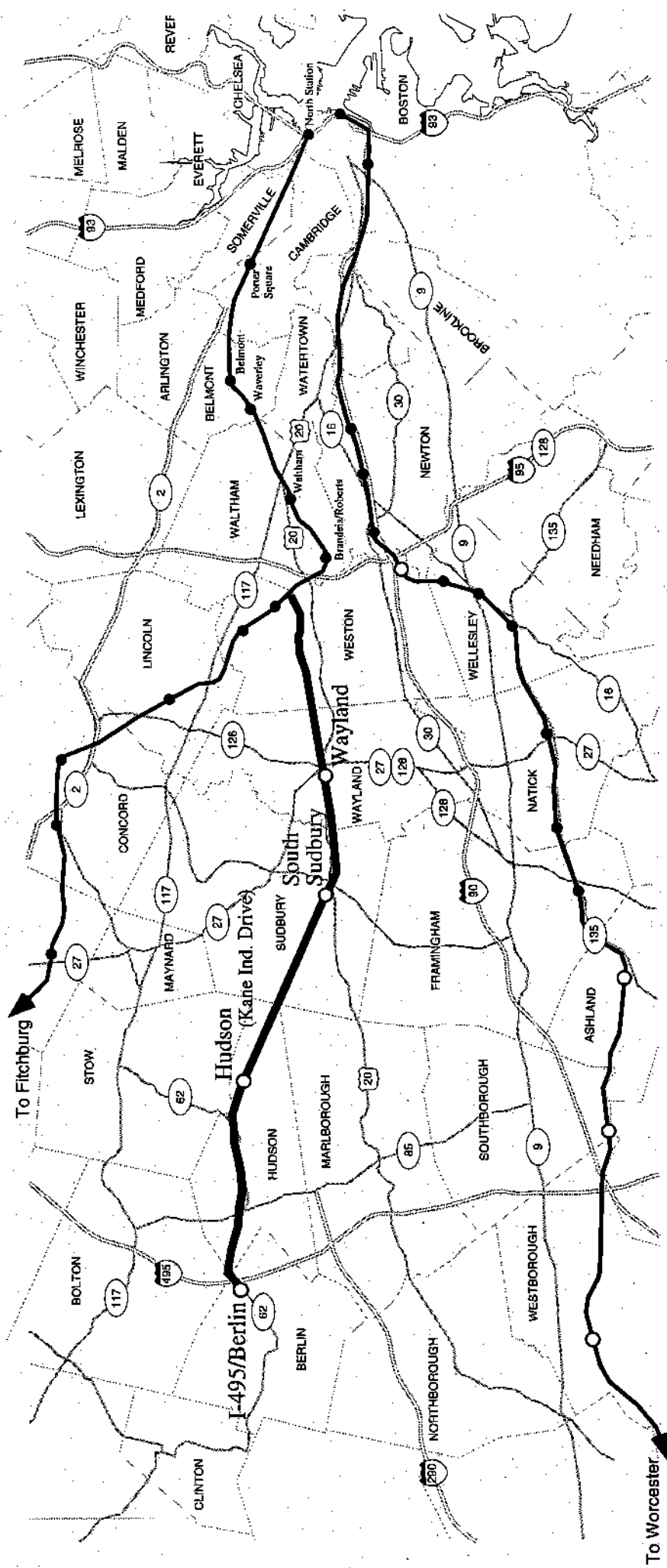
Project Description

The line being examined is part of the former Central Massachusetts, or Central Mass., Branch of the Boston & Maine Railroad system. A Route 495 terminal would be in the town of Berlin. The line would also pass through Hudson, Sudbury, Wayland, and Weston (see map on next page). When last operated, Central Mass. trains diverged from the Fitchburg commuter rail line at a junction 1.5 miles east of the current Waltham Station. Future service would most likely use a new connection to the Fitchburg Line located between the Brandeis/Roberts and Kendal Green stations.

Most portions of the Central Mass. that would be used for the extension have been inactive since at least 1980. (Freight service on the 1.5 miles of the Central Mass. nearest the old junction with the Fitchburg Line in Waltham was operated until 1994.) The outer end beyond Hudson has been inactive since 1975. The right-of-way to a point about two miles west of I-495 is owned by the MBTA. The line beyond that, to Clinton, was dismantled in 1959, and ownership of the property has become fragmented.

Identification of specific station locations for reinstituted service would require further study. The demand analysis, and preliminary examination of present land use in the corridor, indicate that in addition to the terminal at I-495, a Central Mass. extension should include one station each in Sudbury, Hudson, and Wayland.

ALIGNMENT AND STATIONS



LEGEND	
	Potential commuter rail line and station
	Existing commuter rail line and station
	Planned future station on existing line
	Interstate
	State highway

Ridership Potential

The four outer towns along the route of a Central Mass. commuter rail extension to Route I-495 do not currently have direct commuter rail service, but Weston has three stations on the Fitchburg Line. In addition, Wellesley Farms Station on the Framingham Line is less than half a mile outside of Weston, and a new station on that line in Weston is planned. Wayland adjoins three towns with commuter rail stations, and Sudbury adjoins two.

Because of the proximity of the Central Mass. route to other commuter rail lines, virtually all ridership on a Central Mass. extension would be drawn from nine municipalities: Wayland, Sudbury, Hudson, Stow, Bolton, Berlin, Marlborough, Clinton, and Boylston. (See map on page 4.) Total ridership would be relatively low. On weekdays, there would be about 1,300 riders in each direction, and over half of these would be diverted from other MBTA services. Central Mass. ridership would be generated from the markets discussed below. These results are summarized in Table ES-1.

Work Trips to Boston and Cambridge

The predominant source of ridership on all MBTA commuter rail lines is work trips to Boston and Cambridge. Based on the shares of work trips captured by existing North Side commuter rail lines from communities at comparable distances from Boston, a Central Mass. extension with service frequency similar to that on the Fitchburg Line, but with unconstrained parking, could be expected to capture about 40% of the work trips to Boston Proper and 15% to other parts of Boston or to Cambridge from its service area. The 1990 Census Journey-to-Work tabulations (the most recent such figures available) show combined totals of 1,665 Boston Proper, 1,465 Boston Other, and 950 Cambridge work trips from the Central Mass. service area by all modes. With the shares listed above, a Central Mass. extension would capture 1,030 of these trips.

Work Trips to Other Locations and Non-Work Trips

The 1993 survey results show that work trips account for 86% of total commuter rail trips to Boston and Cambridge on North Side lines, and that Boston and Cambridge trips for all purposes account for 92% of trips to all destination. With similar proportions, a Central Mass. line would be expected to attract about 165 non-work trips to Boston or Cambridge and about 100 trips to other destinations.

Total Ridership

The combined ridership from all sources discussed above would total 1,295 per weekday in each direction for a Central Mass. extension terminating at Route I-495 in Berlin. Almost as many riders (1,245) would be served by an extension terminating near the intersection of Main Street and Kane Industrial Drive in the

east end of Hudson. With the same service frequency (16 round-trips per day), an extension to South Sudbury would have 1,160 riders each way. With the minimum level of service analyzed (8 round trips per day, no weekend service), this would drop to about 950.

Adjustment of 1990 Demand Estimates to 1996 and Future Years

The overall population of the Central Mass. service area towns increased by about 5% between 1990 and 1996. A proportional increase in travel would have raised Central Mass. ridership on an I-495 extension by about 65. As a result of economic conditions, however, total Boston employment was about the same in 1996 as in 1990. Therefore, it was concluded that Central Mass. ridership projections based on 1996 travel data would not have differed significantly from those based on the 1990 data.

The Metropolitan Area Planning Council (MAPC) estimates that total population in the Central Mass. service area will increase by about 15% between 1990 and 2020. A proportional increase in ridership on the Central Mass. as a whole would raise weekday inbound boardings to 1,490. The projected employment increase in the City of Boston between 1990 and 2020 is only 5%, however. Unless a disproportionate share of new jobs in Boston went to Central Mass. area residents, a maximum of about 1,360 riders would be more likely.

Shifts from Other Transit Services

Currently about 655 residents of cities and towns in the Central Mass. service area use MBTA commuter rail, express bus, or rapid transit lines for all trip purposes combined on a typical weekday. Another 60 use private-carrier express buses. Current transit users would be among the most likely travelers to shift to a Central Mass. extension. If all of them diverted, only 580 of the 1,295 inbound Central Mass. riders at present levels would be new transit users. Future service improvements on the Fitchburg and Framingham/Worcester commuter rail lines will increase their attractiveness to residents of the Central Mass. service area. By the year 2020 this would reduce the number of Central Mass. riders who would not otherwise be transit users to around 520 per day. At present ridership levels, an extension to a Hudson terminal would attract about 550 new transit users. An extension to South Sudbury with reduced service levels would attract about 420 new riders.

The ridership figures above include only boardings on the Central Mass. extension itself. As a result of diversions to stations on the extension, about 140 parking spaces would be vacated at Fitchburg Line stations where ridership is now severely constrained by parking capacity. Most of the vacated spaces would be refilled by passengers who currently drive to Alewife Station.

Central Mass. trains could stop at some or all of the existing stations on the Fitchburg Line between North Station and the junction with the extension. This could be done either to increase the frequency of service at these stations or to allow Fitchburg Line trains to omit them to speed up service from points further west. Based on sensitivity of ridership to frequency and travel time, the strategy of increasing service at the inner stations would have the larger ridership impact. Up to 200 additional inbound boardings per day would be attracted to these stations. Speeding up service at the outer stations would generate more new revenue, however, because of the higher average fares at these stations.

Table ES-1
Central Mass. Extension
Estimated Weekday Inbound Riders by Category

<u>Ridership Category</u>	<u>I-495/Berlin Terminal</u>	<u>Hudson Terminal</u>	<u>So. Sudbury Terminal</u>
Boston and Cambridge Work Trips	1,030	990	825
Boston and Cambridge Non-Work Trips	165	160	75
Other Destinations - All Trip Purposes	<u>100</u>	<u>95</u>	<u>50</u>
Total	1,295	1,245	950
New Transit Users in Total Above	580	550	420
Diversions from Other Transit Services	715	695	530

Operating Cost and Revenue Estimates

Operating costs for a Central Mass. extension would be determined primarily by the length of the route and the number of trips operated each day. As alternatives to an extension to I-495, the study examined shorter extensions terminating at Main Street near Kane Industrial Drive (referred to for simplicity in this report as Kane Drive) in the eastern edge of Hudson or at South Sudbury. The maximum service frequency analyzed was the same as that currently operated on the inner half of the Fitchburg Line: 16 round-trips on weekdays, 8 on Saturdays, and 7 on Sundays. The minimum frequency considered was weekday service the same as that operated on the outer end of the Haverhill Line (8 round trips), but with no weekend service.

A terminal at I-495 in Berlin would be 31.1 miles from North Station. At the upper-bound service level and the current average operating cost per train-mile, the annual operating cost for this alternative would be \$12 million. (This assumes that there would be a layover facility at the outer terminal, so that no non-revenue miles would be needed.)

Under the present fare structure, at the estimated ridership level of 1,295 weekday riders, and with weekend ridership in typical proportion to this, annual revenue would be \$1.9 million, equal to 16% of the annual cost. Net changes in ridership on other MBTA services as a result of the Central Mass. extension would reduce revenue on those services by about \$0.4 million, however. Therefore, incremental system revenue would equal only 12% of the operating cost of an I-495 extension with maximum service levels.

Of the alternate terminal and service level strategies examined, an extension only to South Sudbury with reduced weekday frequency and no weekend service would have the highest incremental revenue-to-cost ratio, at 27%.

Capital Cost Estimates

Estimated capital costs for Central Mass. extensions to I-495, Hudson (Kane Drive) and South Sudbury are summarized in Table ES-2. It should be noted that these are based on a preliminary examination of the facilities needed, rather than on detailed engineering studies. From a connection with the Fitchburg Line between Brandeis/Roberts and Kendal Green to I-495, the length of a Central Mass. extension would be 18.4 miles. Most of the rails and ties on the Central Mass. line are still in place, but they were in poor condition even before freight service was discontinued in 1980. Normal weathering since then has caused further deterioration of the ties and roadbed. The track structure would have to be entirely rebuilt for future service. In the past, the only signals on the Central Mass. were at the approaches to junctions with other rail lines, so an entirely new signal system would be needed.

Between the connection with the Fitchburg Line and I-495, the Central Mass. right-of-way has 26 crossings of public roads and at least 5 crossings of private roads. When service was last operated, the public crossings were protected by automatic flashing lights but not gates. The crossing protection devices have all been either removed or vandalized beyond repair. Future service would require new lights and gates at all of the public crossings. The crossings are most heavily concentrated on the west end of the line, with 18 public and 2 private crossings between South Sudbury and I-495. Of these, 14 would be west of a Hudson station site at Kane Drive.

The Central Mass. crossed 2 roads on bridges. Both bridges were in Hudson, west of Kane Drive, and both have been removed. Four rivers or streams were crossed on long wooden-pile trestles. Although these are still in place, they would need to be rebuilt or replaced for future rail service. Three of these are west of Kane Drive.

Eight roads crossed the Central Mass. right-of-way on bridges. Two of these bridges in Hudson (both west of Kane Drive) and one in Weston have been

Table ES-2
Summary of Capital Costs for Central Mass. Extension

<u>Item</u>	<u>To I-495/Berlin</u>	<u>To Hudson</u>	<u>To South Sudbury</u>
Track and Signals	\$47,710,000	\$33,045,000	\$20,695,000
Connection to Fitchburg Line	3,000,000	3,000,000	3,000,000
Grade Crossing Surface, Lights, Gates	3,415,000	1,705,000	1,080,000
Fencing	710,000	500,000	315,000
Bridges	17,370,000	6,690,000	2,975,000
Station Platforms and Shelters	3,215,000	2,410,000	1,610,000
Parking	2,670,000	2,580,000	2,040,000
Layover Facility	1,000,000	1,000,000	1,000,000
10% Contingency Factor	7,910,000	5,095,000	3,270,000
Rolling Stock	<u>16,200,000</u>	<u>16,200,000</u>	<u>10,800,000</u>
Total	\$103,200,000	\$72,225,000	\$46,785,000

removed and replaced with solid fill. The other 5 road bridges are still in place and do not appear to require any upgrading.

The I-495, Hudson, and Wayland stations would be at locations where there have not previously been stations, so entirely new facilities would be needed. The old South Sudbury Station site still has a low-level platform, but lacks a shelter, wheelchair ramp, and parking lot. The operating cost calculations assume that there would be a layover facility at the outer terminal to avoid costs for non-revenue train trips.

At the projected ridership levels on the Central Mass., the maximum load on an individual train (excluding boardings at stations on the Fitchburg Line) would be about 360. To provide seats for all of these passengers, trains of either two double-deck or three single-level coaches would be sufficient. The costs in Table ES-2 are based on double-deck coaches. At the estimated running times, an extension to I-495 would require three train sets for five A.M. peak trips.

If the operating strategy for the Central Mass. resulted in significant numbers of present Fitchburg Line riders using Central Mass. trains at the inner stations, additional cars would be needed on some Central Mass. trains. (The most heavily used A.M. peak train on the Fitchburg Line has about 160 passengers boarding at all stations in Waltham and Belmont combined.) The capital cost calculations assume that if this occurred, some cars now assigned to Fitchburg Line trains would be reassigned to Central Mass. trains. If this were not possible, rolling stock costs for the Central Mass. trains would be higher than shown.

It does not appear that Central Mass. service would cause any capacity problems at North Station when added to other existing and currently planned services there.

Environmental Impacts of Central Mass. Extension

Impacts on Air Quality

Based on the present travel modes of the expected users of Central Mass. rail service, and including new ridership on the Fitchburg Line resulting from operation of Central Mass service, a Berlin extension would reduce automobile vehicle miles of travel (VMT) by about 32,700 per day. With a Hudson terminal, the reduction would be about 30,800. For an extension only to South Sudbury with a reduced service level, the VMT reduction would be about 21,000. Taking into account increased emissions from diesel locomotives used on Central Mass. trains, the net impacts on air quality would be as shown in Table ES - 3.

Table ES-3
Central Mass. Extension
Net Changes in Average Weekday Emissions

	I-495/Berlin Terminal	Hudson Terminal	So. Sudbury Terminal
CO change	-282.7 kg	-271.1 kg	-195.1 kg
NOx change	+436.5 kg	+354.0 kg	+134.6 kg
VOC change	-14.8 kg	-15.6 kg	-14.0 kg
PM change	+6.5 kg	+5.3 kg	+2.2 kg

These impacts would be about average compared with other commuter rail extensions examined in the 1994 Program for Mass Transportation. The Central Mass. extension's capital cost relative to air quality improvement would put it among the least cost-effective of those extensions, however.

Impacts on Water Resources

The impacts of a Central Mass. extension on water resources would occur mainly at stations. Parking facilities would require appropriate drainage systems to prevent runoff of motor oil and other pollutants deposited by automobiles. Two of the most likely station sites (I-495 and South Sudbury) would probably require some filling of wetlands in order to provide sufficient parking. The Wayland station would most likely be at one of several vacant industrial sites, where construction of a station would allow mitigation of past impacts on water resources.

All track bridges over rivers and streams on the Central Mass. alignment would be reconstructed as part of the extension project. The present open-deck structures would be replaced with closed-deck bridges, which would have appropriate drainage systems to prevent water pollution.

Impacts on Cultural and Community Resources

A Central Mass. extension would affect community and cultural resources in two towns. In Wayland Center, the right-of-way passes directly through the town's historic district and also runs near the town library. In Hudson, it passes close to two churches and an elementary school. (The impacts in Hudson would occur only with an extension west of Kane Drive.)

Traffic Impacts on Major Arterial Routes

The reductions in vehicle miles of auto travel that would result from a Central Mass. extension would be distributed over many different routes. The greatest reduction at any individual location would occur on Route 20 at the Wayland/Weston town line. With an I-495 or Hudson terminal, the daily reduction at this point would be about 485 cars in each direction. The highest concentration of these would occur between 8:00 and 8:30 A.M., when about 135 cars would be removed. This would be about 17% of the eastbound traffic on the road in this interval. A South Sudbury terminal with reduced service would have a slightly lower impact in the peak half hour. The daily reduction would be about 400 vehicles in each direction.

Traffic Impacts of Station Access

With stations at I-495, Kane Drive in Hudson, South Sudbury, and Wayland, the most heavily used of the four, regardless of specific location, would be the one serving Wayland. At this station, with the maximum service level examined, the most heavily used train would have about 180 boardings. About 150 of the passengers for this train would use some form of auto access. In the final minutes prior to train departure, auto arrivals would average about 16 per minute, but not all of these would approach from the same direction. (One potential Wayland station site would be accessed both from Route 20 and from Route 27. Approaching traffic there would be divided among four directions.)

An extension to I-495 with the maximum service level analyzed would require parking capacities of approximately 90 spaces each at I-495 and Hudson, 300 at South Sudbury, and 410 at Wayland. If the extension terminated in Hudson, parking capacity would need to be expanded to 150 there, with no changes at the other two stations. With a South Sudbury terminal and the minimum level of service analyzed, South Sudbury would require 345 spaces, but Wayland would need only 335.

Grade Crossings

The Central Mass. alignment from Weston to I-495 has 26 grade crossings of public roads. Of these, 8 are east of South Sudbury, 5 between South Sudbury and Kane Drive in Hudson, and 13 between Kane Drive and I-495. Two of the busiest crossing locations are of Route 20, on the Wayland border and just east of South Sudbury. Elimination of at least one of these through elevation of the track appears to be feasible, but the cost has not been included in the capital costs estimated by this study.

Traffic at each Route 20 grade crossing would be stopped for about 45 seconds for each train. With schedules similar to those on the Fitchburg Line, there would be three to four trains per hour in both directions combined during peak hours. The total delay per hour to highway traffic at each crossing would be less than the total hourly delay at any of the present signalized intersections along Route 20.

In addition to the grade crossings on the Central Mass. route itself, Central Mass. trains entering the Fitchburg Line at a junction between Kendal Green and Brandeis/Roberts would pass through 8 grade crossings on that line. This would include 4 crossings in Waltham, 1 each in Belmont and Cambridge, and 2 in Somerville. The most heavily traveled of these is the Moody Street crossing in Waltham, which is located between the outbound and inbound Waltham Station platforms. This crossing is viewed by the City of Waltham as a serious impediment to traffic flow even with existing rail service levels. Additional traffic studies would be needed to determine the impact of adding Central Mass. service.

Impact of Extension on Abutters

The segments of the Central Mass. line that would be used for a commuter rail extension have had no train operation at all since 1980 or longer. In the final years before abandonment, traffic on the line consisted at most of one local freight train per day in each direction. Negative impacts on abutters of the commuter rail service would include vibration and noise and blocking of road crossings while trains are passing. The sounds that would carry furthest would be those of train horns at the crossings.

There are currently about 150 houses within 200 feet of the Central Mass. right-of-way. Of these, about 50 are east of South Sudbury, 40 between South Sudbury and Kane Drive in Hudson, and 60 between Kane Drive and I-495. Many of these have been constructed since rail service was last run on the line. Additional subdivisions are now being developed close to the line in Wayland.

Most of the houses close to the right-of-way would be too far from the most likely station sites to be impacted by station traffic. Traffic past houses along

Route 20 east of South Sudbury would decrease slightly because of diversions to the rail line.

Conclusions

A Central Mass. commuter rail extension to either Route I-495 in Berlin or to South Sudbury would be feasible from an operations standpoint but would produce very limited benefits for the costs involved.

Depending on the outer terminal location and level of service, the extension would carry about 950 to 1,300 inbound riders per day, at current travel levels. About half of these would be new transit users. The total would increase only slightly in future years. Incremental fare revenue from an I-495 extension would cover only about 12% of incremental operating cost. An extension only to South Sudbury with minimum acceptable service would have a revenue-to-cost ratio of about 27%. The capital cost per new transit user would be \$171,931 with an I-495 terminal, \$131,318 with a Hudson terminal, or \$111,393 with a South Sudbury terminal. All three alternatives would be among the most costly per new transit rider of any MBTA commuter rail extensions analyzed recently.

Line-haul rail travel times to Boston would, at best, be about the same as those for single-occupant auto trips from Sudbury, Wayland, or Hudson, but several minutes longer than auto times from I-495. Rail times would be significantly faster than current scheduled express bus times from the corridor, but few corridor residents now use the buses.

A Central Mass. extension to any of the terminals examined would produce a relatively small improvement in air quality. The capital cost per weekday kg of VOC elimination would range from \$3.3 million for a South Sudbury extension to \$7.0 million for an I-495 extension. In this measure, it would rank among the least cost-effective of the commuter rail improvement projects examined in the MBTA's 1994 Program for Mass Transportation, when increases in locomotive emissions are included.

Table ES-4
Summary of Performance Measures for
Central Mass. Extension to I-495, Hudson, or South Sudbury

<u>Item</u>	<u>To I-495/Berlin</u>	<u>To Hudson</u>	<u>To South Sudbury</u>
Weekday Inbound riders	1,295	1,245	950
New Transit Riders Included Above	580	550	420
Annual Operating Cost	\$11,995,000	\$9,830,000	\$3,315,000
Incremental Fare Revenue	\$1,445,000	\$1,375,000	\$910,000
Incremental Revenue/Operating Cost	0.121	0.140	0.274
Capital Cost	\$103,200,000	\$72,225,000	\$46,785,000
Capital Cost/New Transit Rider	\$177,931	\$131,318	\$111,393
Capital Cost/Kg of Weekday VOC Reduction	\$6,973,000	\$4,630,000	\$3,342,000

Note: South Sudbury figures are based on reduced weekday service, with no weekend service.

1. INTRODUCTION

During the past 25 years the Massachusetts Bay Transportation Authority (MBTA) and the Executive Office of Transportation and Construction (EOTC) have acquired over 600 miles of railroad rights-of-way, mostly in eastern Massachusetts. Of these lines, about one quarter are currently inactive but the corridors of inactive lines are being preserved for possible future transportation uses. One such corridor is the former Boston & Maine Railroad Central Massachusetts, or Central Mass., Branch between Waltham and Berlin. This line last had passenger service in 1971 and freight service in 1980. It is now owned by the MBTA.

Because of changes in population and employment, some residents of the Central Mass. corridor have recently expressed interest in reestablishing passenger service on the line. A provision in the Massachusetts state budget for fiscal year 1996 directed EOTC, as part of its Rail Planning Program, to conduct a feasibility study of reopening the Central Mass. line as far as Route I-495 (in Berlin). This report presents the results of the feasibility study, which was performed for EOTC and the MBTA by the Central Transportation Planning Staff. A separate CTPS study is examining the feasibility of converting the Central Mass. right-of-way into a bicycle path as an alternative to restoring rail service at this time.

2. SERVICE AREA

Communities to Be Served

The map on page 4 depicts the service area of a Central Mass. extension. The reasons for defining the service area as shown are set forth below.

The majority of inbound passenger trips on existing MBTA commuter rail lines originate in the cities or towns served directly by these lines.¹ Most other trips originate in towns adjoining those with stations, but the outermost station on a line often attracts riders from greater distances than do the intermediate stations. A Central Mass. commuter rail line would have a much smaller service area than would be expected under these guidelines, however.

A Central Mass. rail extension would branch from the existing Fitchburg commuter rail line in Waltham or Weston and extend through the towns of Wayland, Sudbury, and Hudson, to Route I-495 in Berlin.² Waltham is currently served by two stations on the Fitchburg commuter rail line (Brandeis/Roberts and Waltham). Weston has three stations on the Fitchburg Line (Kendal Green, Hastings, and Silver Hill). Wellesley Farms Station on the Framingham/Worcester Line is less than half a mile from the border of Weston. A new station on the Framingham/Worcester Line in Weston near the Mass. Turnpike/Route 128 interchange is under design. Therefore, providing additional stations in either Weston or Waltham on the Central Mass. would attract few, if any, new commuter rail riders. (As discussed in chapter 4, using Central Mass. trains to increase overall service frequency at existing stations would attract some new riders.)

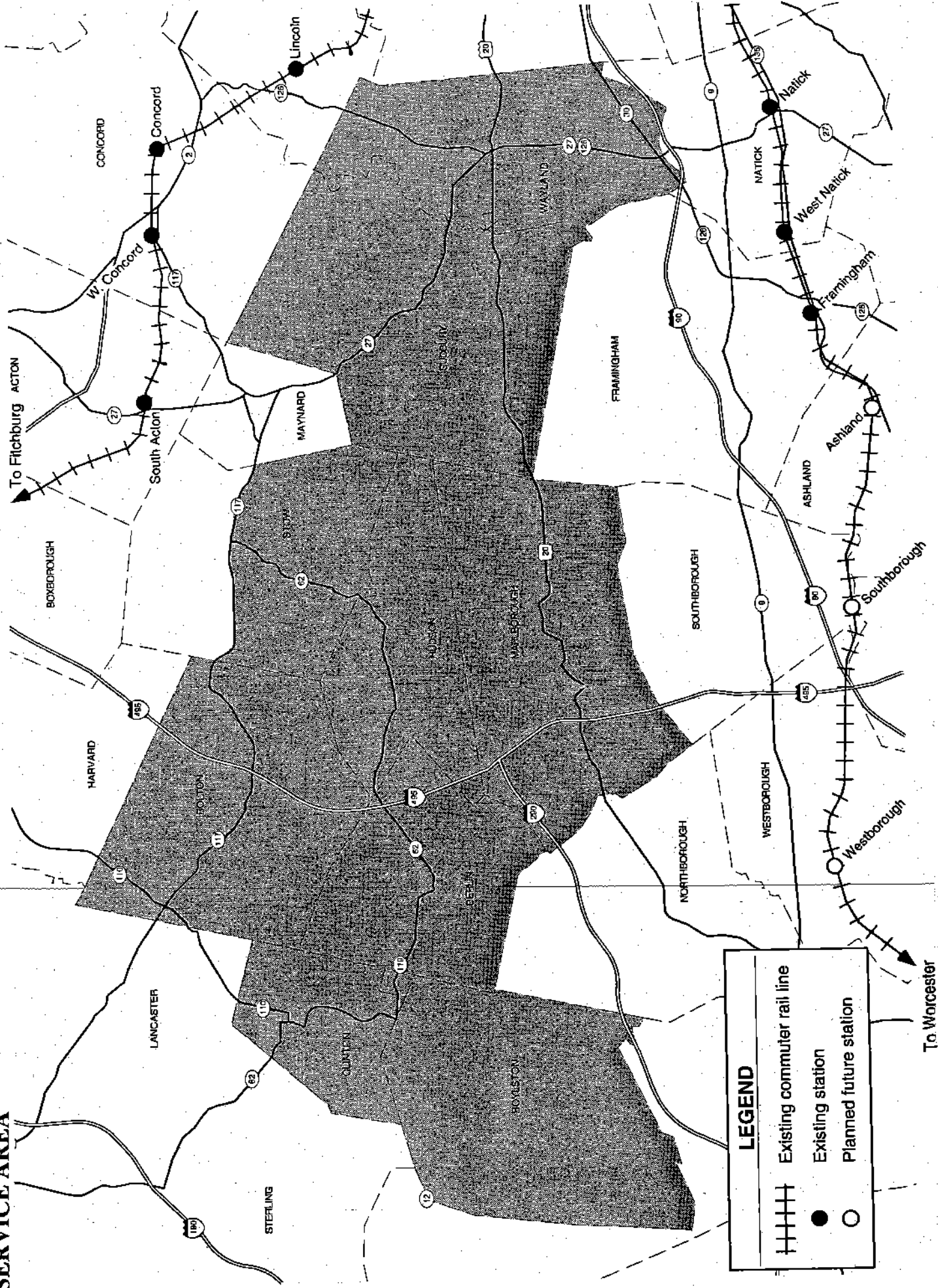
None of the four other towns along the Central Mass. route has direct rail passenger service, but Wayland adjoins three other towns with stations and Sudbury adjoins two. The towns adjoining Weston, Wayland, Sudbury, Hudson, and Berlin to the north are Lincoln, Concord, and Acton, which all have stations on the Fitchburg Line, and Maynard, Stow, and Bolton, which have no direct rail service. The adjoining communities to the south are Wellesley, Natick, and Framingham, which all have stations on the Framingham/Worcester Line, and Marlborough and Northborough, which currently have no rail passenger service. Adjoining towns to the west are Clinton and Boylston, neither of which has rail passenger service.

¹Results of the 1993 MBTA commuter rail survey show that on-line origins exceeded 67% on all but the Fairmount Line (65%) and the Attleboro/Stoughton Line (55%). The Attleboro/Stoughton Line has several large regional parking facilities near major commuting highways.

²The right-of-way enters the town of Bolton for about 600 feet between Hudson and Berlin, but a station there is unlikely. Therefore, Bolton is not treated as an on-line town in this study.

T CENTRAL MASS. COMMUTER RAIL Feasibility Study

SERVICE AREA



Central Mass. trains would operate into Boston over the Fitchburg Line and terminate at North Station, like Fitchburg Line trains. The most likely station sites on the Central Mass. (discussed in chapter 3) would have less convenient access than existing Fitchburg Line stations for residents of Lincoln, Concord, Acton, and Maynard. Therefore, ridership attracted to the Central Mass. from any of these towns would be insignificant. Residents of sections of Stow south of the town center would have shorter access to a Central Mass. station in Hudson than to present Fitchburg Line stations, so that portion of Stow is included in the Central Mass. service area.

Central Mass. service would give residents of towns to the south of its alignment a new option of riding to North Station or Porter Square instead of Back Bay or South Station. Even on existing North Side lines, however, survey results show that the majority of riders have destinations at least as close to Back Bay or South Station as to North Station. For purposes of analysis, it is assumed that the number of Wellesley, Natick, and Framingham residents who would choose to use the Central Mass. rather than the Framingham/Worcester Line would be offset by Sudbury and Wayland residents who would be expected to divert to the Central Mass. but would actually continue to use the Framingham/Worcester line.

Of the other two communities to the south, Marlborough would be best served by a Central Mass. extension, but Northborough would be better served by the planned new station in Westborough on the Framingham/Worcester Line. To the west, Clinton and Boylston would be in the Central Mass. service area. Towns further to the west would not have good access to Central Mass. stations and they generate few trips to Boston or Cambridge. Therefore, ridership from beyond Boylston and Clinton would be insignificant.

Existing Transportation Services

Present Railroad Facilities In Service Area

A Central Mass. commuter rail extension would use the right-of-way of the former Boston & Maine Railroad Central Mass. Branch. This line is currently inactive, but is owned by the MBTA. Passenger train service on the Central Mass. line was last operated in 1971. Freight service was officially discontinued between Waltham and Berlin in 1980, but had not been run between Hudson and Berlin since 1975.³

Two towns on the Central Mass. route, Sudbury and Berlin, are also on active rail lines now used only for freight service. These lines connect with the Framingham/Worcester commuter rail line at Framingham Station. Passenger

³Freight service on the 1.5 miles of the Central Mass. nearest the old junction with the Fitchburg Line in Waltham was operated until 1994.

service on both lines was last operated in the 1930s. (The current owner and operator of the lines, Conrail, has announced plans to sell them to RailTex, an independent operator of regional rail systems.) Use of either or both of these lines as alternatives to service on the Central Mass. route would be technically feasible, but a detailed analysis of such service is outside the scope of this study.

Present Highway Facilities in Service Area

A Central Mass. extension would be used predominantly for travel from communities in its corridor to Boston and Cambridge. Such travel is on a west-east orientation. Of the towns that would have stations on the extension, only Weston is served directly by a west-east limited-access highway. Mass. Turnpike Exit 14 is located in the southeast corner of the town. The Turnpike also passes through the southern edge of Wayland, but the nearest access point is Exit 13 in Framingham, at the Natick town line.

The primary west-east highway for Sudbury, Wayland, and much of Weston is U.S. Route 20. This is an undivided, mostly two-lane road with unlimited access and several traffic lights. Route 20 connects in Waltham with Route 128. Traffic destined for Boston and Cambridge from Route 20 can continue on Route 128 either south to the Mass. Turnpike or north to Route 2. State Route 30, another two-lane undivided road, provides an alternative to Route 20 from points in the southern edge of Wayland and Weston. It connects with the Mass. Turnpike and with Route 128 in Weston.

Hudson and Berlin both have very indirect highway access to Boston and Cambridge. Route I-495, which runs along the border between Hudson and Berlin, has a north-south orientation but connects with Routes 2, 20, and 9 and the Mass. Turnpike for west-east travel. It is also possible to reach these west-east highways over a variety of local roads and secondary state highways.

Traffic on Route 20 was examined by CTPS in studies published in 1988 and 1991.⁴ Travel time runs conducted for the 1988 study found that speeds on all segments of Route 20 between Marlborough and Route 128 averaged less than 40 m.p.h. for eastbound A.M. peak and westbound P.M. peak traffic. The eastbound A.M. peak speed averaged 38 m.p.h. in Sudbury and 35 m.p.h. in Wayland, but only 24 m.p.h. in Weston. (Informal reports indicate that average speeds have decreased slightly since 1988, but comparable timing run data are not available.)

Timing runs on Route 128 and the Mass. Turnpike were conducted by CTPS in 1995. Combining the results of these with the 1988 results for Route 20, total

⁴CTPS, *Route 20 Corridor Planning Study: Short Range Element* (1988); CTPS, *Route 20 Corridor Planning Study: Long-Range Element* (1991)

driving times to the South Station exit of the Turnpike in the peak 30 minutes would be about 36 minutes from South Sudbury, 30 from Wayland Center, and 22 from Weston Center. Times to Copley Square, including egress from the Turnpike, would be about 2 minutes longer than these. (Several alternate routes from these towns to the Turnpike over local streets can be taken, but none would have significantly faster travel times than these.) Present scheduled times for bus service to Boston on this combination of routes allow 6-8 minutes longer than the driving times calculated above.

Present Public Transportation Serving the Study Area

Commuter Rail

Of the cities and towns directly on the Central Mass. alignment, only Waltham and Weston are currently served directly by other commuter rail lines. (Because of the amount of existing service, it is unlikely that new stations would be established on the Central Mass. in either Waltham or Weston. Present rail service in these two communities is discussed in greater detail in the first section of this chapter.) Commuter rail riders from the cities and towns in the Central Mass. service area currently use stations on the Fitchburg or Framingham/Worcester lines. The Fitchburg Line runs through towns to the north at distances ranging from 1 to 10 miles from the Central Mass. route. The Framingham/Worcester line runs through towns to the south at distances of 3 to 10 miles from the Central Mass. A station in Weston on this line near Mass. Turnpike Exit 14 is under design. There are currently no intermediate stops between Framingham and downtown Worcester but locations for additional stations in Ashland, Southborough, Westborough, and Grafton and on the east side of Worcester are now being finalized. The service areas of most of these would overlap that of the outer end of a Central Mass. extension.

According to expanded 1993 survey results, on a typical weekday 358 inbound commuter rail trips originated in the nine cities and towns that would generate most of the ridership on a Central Mass. extension. Of these trips, 222 were made on the Fitchburg Line and 136 on the Framingham/Worcester Line. Origins by city or town are shown in Table 2-1.⁵

Other MBTA Service

No MBTA service other than commuter rail is operated directly in any towns in the Central Mass. corridor. Survey results show that corridor residents make use of MBTA services at several other locations, however.

⁵Service on the Framingham Line was extended to Worcester in September 1994. Boardings at Worcester are based on a survey conducted in February 1995.

Table 2-1
Weekday Inbound Ridership at Present Commuter Rail Stations for Trips
Originating in Central Mass. Service Area

Boarding Sta.	Origin									Total
	Wayland	Sudbury	Hudson	Bolton	Berlin	Stow*	Marlboro	Clinton	Boylston	
<i>Fitchburg Line</i>										
Littleton/495				2				1		3
So. Acton		4	16	16		25	2	14		77
W. Concord		3	2					5		10
Lincoln	10	67	3				9			89
Kendal Green	22	7								29
Brandeis				3						3
Waltham							11			11
Subtotal	32	81	21	21	0	25	22	20	0	222
<i>Framingham Line</i>										
Worcester								2	1	3
Framingham		2	4				37		2	45
West Natick	1	5					5			11
Natick	23									23
Wellesley	9						3			12
Wellesley Hills		2								2
Welles. Farms	7	3								10
Auburndale	27	3								30
Subtotal	67	15	4	0	0	0	45	2	3	136
Total	99	96	25	21	0	25	67	22	3	358

*Origins from Stow include only those from south of the town center.

The MBTA Riverside terminal in Newton is near the Grove Street exit from Route 128, about three miles south of the interchange between Routes 20 and 128. At Riverside, all-day light rail service to Boston at intervals of 5 to 10 minutes is provided by the Green Line. During peak hours, MBTA bus Route 500⁶ runs between Riverside and the Boston financial district via the Mass. Turnpike. Headways range from 10 to 30 minutes.

⁶MBTA bus Routes 300 and 305 were renumbered 500 and 505 in September 1996.

Some residents of towns in the Central Mass. corridor use MBTA express bus Route 505 (Waltham-downtown Boston) via driving to West Newton or Waltham and parking there. Others use the Red Line, mainly via driving to Alewife Station by way of Route 2.

Recent survey results indicate that about 180 residents of the Central Mass. service area use the Red or Green lines and about 120 use MBTA express buses on a typical weekday. Added to the commuter rail ridership, this makes about 655 weekday MBTA trips in each direction by Central Mass. service area residents.

Private-Carrier Express Bus Service

Two private companies operate express bus routes to downtown Boston from towns directly on the Central Mass. Line, but neither route has frequent service. The Post Road Line, currently operated by Cavalier Coach Corp., runs from Northborough to Boston, serving stops on Route 20 in Marlborough, Sudbury, Wayland, and Weston. There is one inbound A.M. peak trip and one outbound P.M. peak trip on weekdays only, and there are no off-peak trips. Funding for this route is provided by the MBTA/EOTC Interdistrict Transportation Service Program (IDTS). In 1993, ridership averaged 27 passengers each way per day for the entire Post Road route. Current counts for individual boarding locations are not available, but based on old survey results, Marlborough and Sudbury would each account for about 8 riders and Wayland for about 6.

The other express bus route in the Central Mass. corridor, operated by Gulbankian Bus Lines, runs from Hudson to Boston, with intermediate stops in Marlborough, Southborough, and Framingham. Of these locations, only Hudson is directly on the Central Mass. Line, but Marlborough would also be in the Central Mass. service area. This route is unsubsidized. There are three trips per day in each direction, including one inbound in the A.M. peak and one outbound in the P.M. peak. Ridership on the inbound A.M. peak trip averages about 30-35 passengers per day. Of these, about 5 board in Hudson, 10-15 in Marlborough, and 15 in Southborough. (The Framingham stop is rarely used.)

Of the towns located directly on the Central Mass. Line, only Berlin, at the western end of the route, has no bus service to Boston at present. Neither of the towns adjoining Berlin to the west (Boylston and Clinton) have bus service to Boston or have had such service at any time in the recent past.

In addition to the routes described above, Central Mass. corridor residents have access to private-carrier bus routes in several adjoining towns. Recent passenger counts by town of origin for these routes are not available, however.

To the north, Yankee Line, Inc., operates a route from Littleton to Copley Square and Park Street Station in Boston, with intermediate stops in Concord and Acton.

Service on this route consists of one inbound A.M. peak trip and one outbound P.M. peak trip. The stops on this route are further from the Central Mass. Line than stations on the Fitchburg Line, so diversions to the Central Mass. would be insignificant.

To the south, express bus service to Boston from Framingham is currently operated by Peter Pan Bus Lines. All trips on this route stop at Shoppers World, either at the commuter lot at Flutie Pass or at the Massport Logan Express terminal. This service is unsubsidized. There are currently 10 inbound and 12 outbound trips per day serving Shoppers World, including 7 inbound and 6 outbound in peak hours. Four trips in each direction, all in peak hours, continue to the Edgewater apartment complex west of Framingham Center. Recent ridership figures for this route are not available. Based on current service levels and old origin-destination surveys, an estimated 20 to 25 Central Mass. corridor residents board Shoppers World express buses on a typical day.

Peter Pan also operates a local bus on Route 9 between Worcester and Boston, with several stops in Framingham, Natick, and Wellesley. This route, which is subsidized by the MBTA, has seven round-trips a day, including two inbound in the A.M. peak and one outbound in the P.M. peak. This is the only bus service to Boston from Natick or Wellesley. Ridership for the entire route averages fewer than 75 passengers per day in each direction.

All of the private-carrier express bus routes serving the Central Mass. corridor are discussed in greater detail in appendixes A and F. Table 2-2 summarizes present weekday ridership on all mass transit alternatives for trips originating in the Central Mass. service area.

Table 2-2
Weekday Inbound Ridership on Present Mass Transit Services for Trips
Originating in Central Mass. Service Area

<u>Existing Mass Transit Service</u>	<u>Riders from Central Mass. Service Area</u>
Red Line - Alewife	110
Green Line - Riverside	70
MBTA Express Bus Route 500 or 505	120
Framingham Commuter Rail	135
Fitchburg Commuter Rail	220
Private-Carrier Bus	<u>60</u>
Total	715

3. DESCRIPTION OF SERVICE

Alignment

West of Route 128

West of Route 128 (on the border of Waltham and Weston), a Central Mass. extension would use the right-of-way of the former Boston & Maine Railroad Central Mass. Branch. The MBTA-owned segment of this line runs through Weston, Wayland, Sudbury, Hudson, and Berlin (see map on page 12), but at one time the route continued west to Northampton. The main alignment question to be resolved would be how far west to run service.

Past passenger service on the Central Mass. Line operated from many outer turnback locations, but schedules suitable for work trips to Boston were never operated from further than West Boylston. The segment of the line immediately beyond that was abandoned in 1939, and ownership of the former right-of-way there is now fragmented. The towns along that portion of the Central Mass. route have always had low work-trip orientation to Boston and Cambridge. In this study, the only extension west of Route I-495 examined in detail would terminate at Clinton. Such an extension is described in appendix C but is not recommended. (Extensions using a combination of the Central Mass. and other rail rights-of-way intersecting it east of I-495 are also discussed in appendix C but are not recommended.)

The legislation under which this study was performed called specifically for examination of a terminal at I-495. Because of the high cost of such an extension relative to ridership, consideration was also given to a shorter route. Turnback points on the Central Mass. east of I-495 used at various times in the past included Hudson, South Sudbury, and Wayland. Based on the predicted sources of ridership for an extension to I-495, it was concluded that the optimal location for a terminal short of I-495 would be in Sudbury. The only such terminal discussed in detail in this report is South Sudbury, but analysis of alternate locations showed that they would not change the results significantly.

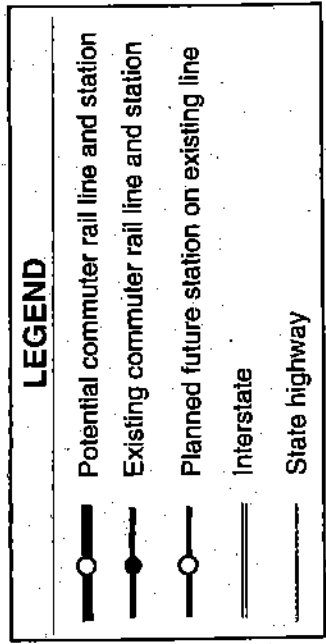
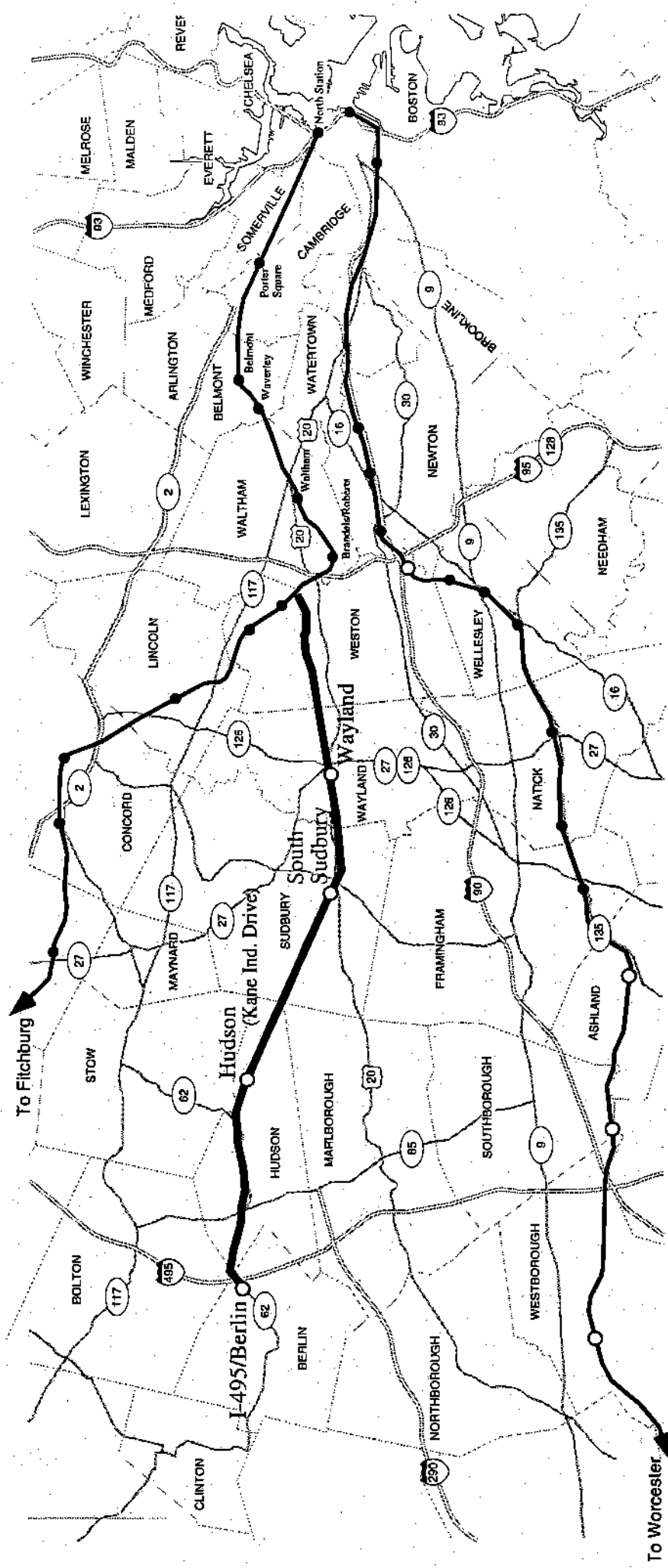
East of Route 128

In the past, Central Mass. trains used several different routings between Waltham and Boston. A description of these routings is provided in appendix B. Alternatives examined in this report are a connection with the MBTA's Fitchburg Line at Clematis Brook Station in Waltham, and a new connection with the Fitchburg Line near the Weston/Waltham border. (See map on page 13.)

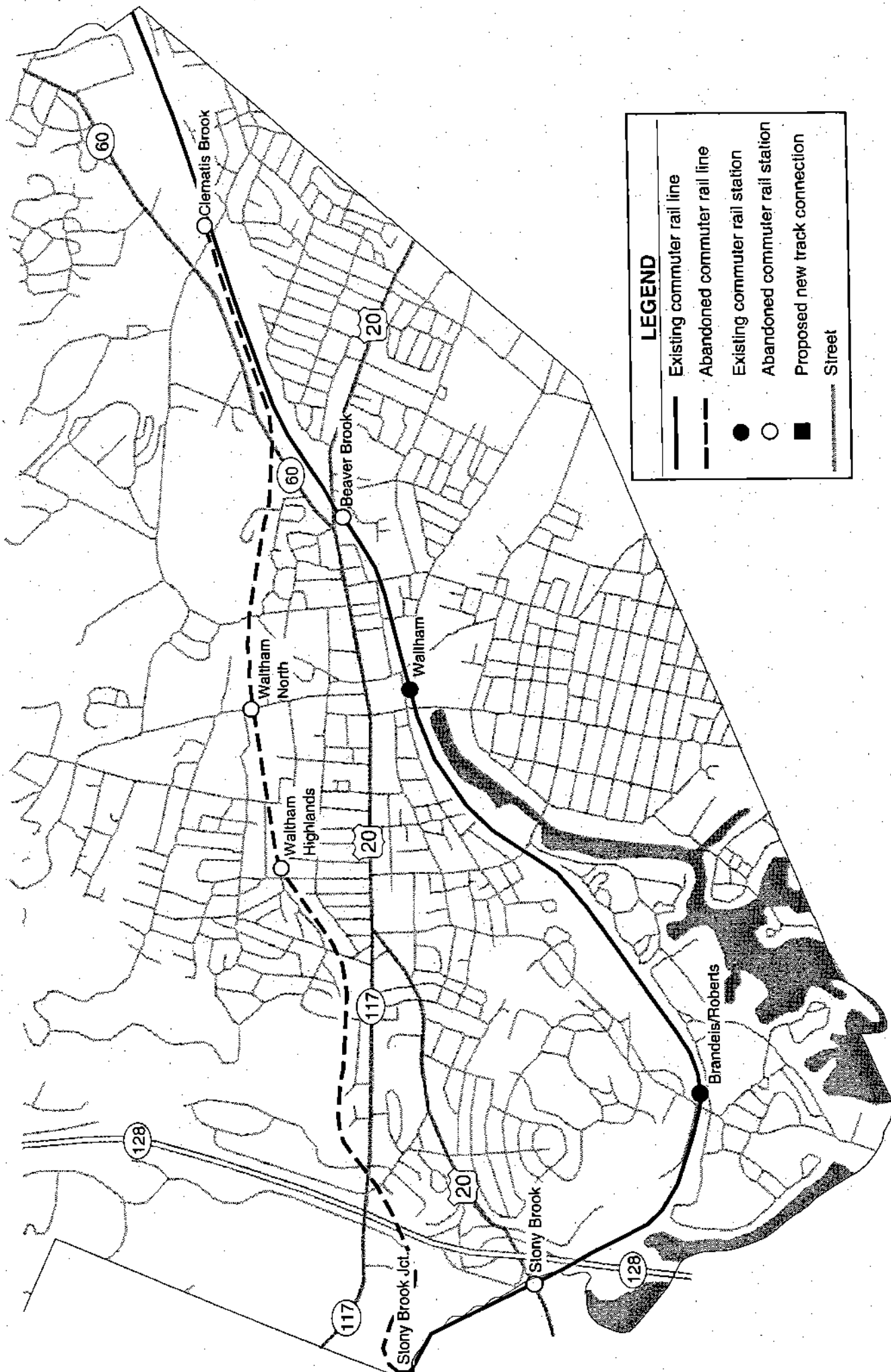
The Central Mass. right-of-way crosses that of the Fitchburg Line on a bridge at a point 0.4 mile east of Kendal Green Station in Weston and 12.8 miles from North Station. As detailed in appendix F, a connection between the two lines at or near

T CENTRAL MASS. COMMUTER RAIL
Feasibility Study

ALIGNMENT AND STATIONS



FITCHBURG LINE AND FORMER CENTRAL MASS. LINE ALIGNMENTS THROUGH WALTHAM



this point was proposed at various times in the past, but was never built. The configuration of such a connection is discussed in more detail in chapter 5. The westernmost named location that trains would pass on the Fitchburg Line before diverging to the Central Mass. via the new connection is the former Stony Brook Station site at the crossing of Route 20. For this reason, the connection is referred to in this study as Stony Brook Junction.

The most recent connection between the Central Mass. and Fitchburg lines was at the former Clematis Brook Station site at Beaver Street in Waltham. This location was 3.7 miles east of Stony Brook Junction via the Central Mass., and 4.5 miles via the Fitchburg Line. It was 8.3 miles from North Station.

Assuming that a connection at Stony Brook Junction is feasible from an engineering standpoint, it would be preferable to a connection at Clematis Brook based on the following considerations.

The area traversed by the Central Mass. right-of-way in Waltham between Stony Brook Junction and Clematis Brook is characterized generally by dense residential development mixed with some commercial and light industrial areas. The land adjoining the Fitchburg Line between the same points is largely non-residential or undeveloped, so the number of abutters impacted by Central Mass. train operation would be much smaller.

On the Central Mass. alignment between Stony Brook Junction and Clematis Brook there are 8 grade crossings of public roads, or an average of 2.2 per mile. In comparison, the Fitchburg Line has only 3 grade crossings in this segment. Among the Central Mass. crossings, the one at Prospect Hill Road where the track intersected the road at a sharp angle on a hillside, was considered to be especially hazardous. After the rail line was abandoned, the road was lowered several feet at the crossing site to provide a more uniform profile with better site lines for drivers. Future rail service would require restoration of the former undesirable road profile. Lexington Street has also been lowered at the former crossing site and would also have to be restored to its old profile.

Trains running through Waltham on the Fitchburg Line can serve the Brandeis/Roberts and Waltham stations. On the Central Mass. alignment there were historically stations at Hammond Street (Waltham Highlands) and Lexington Street (Waltham North), but neither of these is close to a significant activity center. At Waltham Station on the Fitchburg Line, connections can be made with all seven MBTA bus routes serving Waltham. The Central Mass. alignment intersects two of these bus routes at Waltham North and one at Waltham Highlands.

Stations

Identification of specific station sites on a Central Mass. commuter rail extension is beyond the scope of this study. For purposes of analyzing ridership, travel times, and traffic impacts of the extension, however, it was necessary to make some assumptions about approximate station locations. As discussed further in appendix D, good highway access and adequate parking facilities would be critical to the success of a Central Mass. extension, but most of the station sites used in the past lack one or both of these elements. Therefore, several new sites were considered as well. Of the sites considered, the most promising are discussed below. Other sites are discussed in appendix D. Sites in Sudbury and Wayland are shown on the map on page 17.

Route I-495/Berlin

This is the terminal location specified in the legislation under which this study was prepared. The Central Mass. right-of-way crosses under I-495 on the north side of its interchange with Route 62. The rail line was still active when I-495 was built, so bridges were provided. There is currently a town-owned carpool lot between Route 62 and the railroad track west of I-495. This lot has 44 spaces, of which 31 were occupied on a weekday morning in June 1996. There is no public transportation service at this site. There is a large tract of undeveloped land on the opposite (north) side of the railroad track at this point, but it is a swamp. Environmental considerations would restrict the amount of this tract that could be used for parking or layover facilities. Convenient access to this site would require construction of a new road from Route 62 across the right-of-way. The other quadrants of the Central Mass./I-495 crossing do not have enough vacant land for a parking facility.

Hudson/Kane Industrial Drive

The Central Mass. right-of-way crosses Main Street in the eastern side of Hudson near Kane Industrial Drive. This location is between the former Ordway and Gleasondale station sites (discussed in appendix D), but was never a station site in the past. It is in a predominantly industrial area, with sufficient vacant land for both a park-and-ride lot and a layover facility. The station could be located either east or west of Main Street, but a site on the east would eliminate the need for a grade crossing of that street. The station would be 3.3 miles east of downtown Hudson via Main Street. This section of Main Street is not part of a numbered highway, but it is the primary traffic route from Hudson to Sudbury and towns to the east.

South Sudbury

In the past, the main station on the Central Mass. in Sudbury was South Sudbury, located just west of Union Avenue, at the crossing of the Conrail Lowell

Secondary Track. Like other Central Mass. stations, South Sudbury had very limited parking capacity. The largest tract of vacant land near this site is in the northwest quadrant of the crossing of the Central Mass. and Conrail lines. Use of this site for parking would require construction of a new access road from Union Street. Wetlands in the area would limit the overall size of this facility. A parking lot in the southwest quadrant would have better access from Route 20, but might require relocation of some or all of the of the Saxonville Lumber Company's buildings.

Sudbury Landfill

The Sudbury town landfill was located on the north side of Route 20 on the Sudbury-Wayland town line. The Central Mass. right-of-way is about 600 feet south of Route 20 at this point. The landfill was finally closed in the spring of 1996. Environmental regulations require that it be capped and limit its potential redevelopment uses. A commuter parking lot would be an acceptable use for the site. The difference in elevation between the surface of the parking lot and the railroad track, and the need to provide a pedestrian crossing of Route 20 between the parking lot and the platform could present some design problems at this site. The area suitable for parking is mostly 40 to 50 feet above the rail line. Route 20 is at about the same elevation as the landfill. Much of the land south of Route 20 is also at this level, with a sharp dropoff toward the track. Descent to the platform would require use of long ramps or stairs.

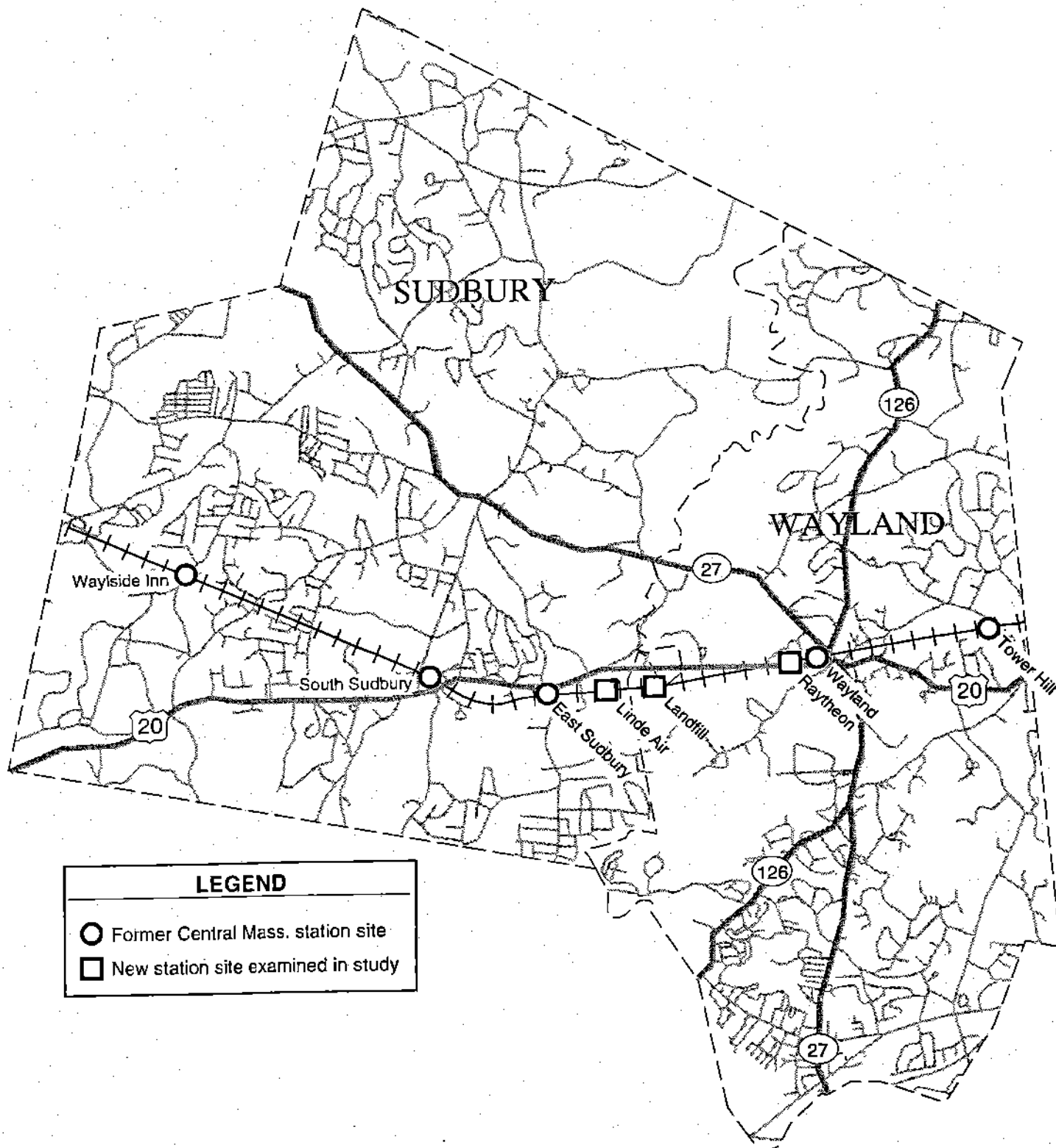
Linde Air Products Company

The design problems at the Sudbury landfill could be avoided by use of the abandoned Linde Air Products Company site 0.6 mile further west on Route 20. The total parking capacity that could be provided there would be about the same as at the landfill. The track there is only slightly lower than Route 20, with a gradual slope down through the parking area. This site would be further from Wayland than the landfill site, however, so a separate station for Wayland would also be needed to maximize ridership.

Wayland Raytheon Site

The Raytheon Company has recently vacated its facility in Wayland. The site borders directly on the Central Mass. right-of-way, one third of a mile west of the old Wayland Station location at Route 27. It has private access roads from Route 27 on the east and from Route 20 on the south. There is already substantial paved parking at this location, but much of the site is occupied by the vacant manufacturing plant. This is a two-story brick building, about 50 years old. It is an irregular shape, with maximum dimensions of about 600 by 800 feet. A vacant building of this size in the middle of a commuter parking lot would present security problems. It would have to be either demolished or redeveloped into some use compatible with a rail station.

**PAST RAILROAD PASSENGER STATION SITES AND
POSSIBLE NEW SITES IN SUDBURY AND WAYLAND**



Layover Facility

The rolling stock used on MBTA commuter rail lines does not necessarily require any special facilities at the end of a line. On a single-track route such as the Central Mass., trains can reverse direction at any desired location, with the engine pulling the train on the outbound trip and pushing it on the inbound or vice-versa. To minimize non-revenue train mileage, however, it is desirable to provide a yard for overnight storage of trains at or near the outer end of a route.

Depending on the outer terminal location and the number of stations served on the Fitchburg Line, a Central Mass. extension would require two to three train sets, each consisting of a locomotive and two to five coaches. This equipment could be kept overnight either in Boston or at a layover facility somewhere along the extension. The latter option would be more efficient in terms of train-mile expenses, as basing trains in Boston would require operation of early-morning outbound and late-night inbound trips that would carry few riders.

With parallel tracks, a layover facility for two trains of three cars each would need to be at least 45 feet wide and 325 feet long, or about one third of an acre. A facility for three trains of five cars would need to be about 60 feet by 500 feet, or 0.7 acres. Parking lots of similar dimensions would hold about 75 to 150 cars. (For greater flexibility in rotating train sets between the Central Mass. and other routes at North Station, even larger layover facilities would be needed.) With limited available land, the tradeoff between parking capacity and layover facility size would need to be taken into consideration.

An alternate layover facility strategy would be to park trains end-to-end either on the former main line beyond the terminal, or on a side track. The total length of the line would be about 1,500 feet for three five-car trains. Parking on the main line would require train sets to be used on a first-in/last-out basis. This could disrupt service severely in the event of equipment failures on the trains parked nearest to the inner end.

Running Times

The running times to Boston for Central Mass. trains would depend on the number and locations of stations served, maximum speed limits, speed restrictions for curves and crossings, and the acceleration and deceleration characteristics of the rolling stock used on the line. For purposes of analysis, it is assumed that travel times for Central Mass. trains while on the Fitchburg Main Line would be the same as the present scheduled times for trains on the same portion of that line serving the same stops.

In its best historical condition, the Central Mass. had an overall maximum speed limit of 50 m.p.h. There were restrictions of 15 to 20 m.p.h. over grade crossings for about half a mile on each side of Route 85 in Hudson. In later years when

crossing protection was downgraded or highway traffic increased speed restrictions were imposed at other streets. These included the crossings of Route 20 in Wayland and Sudbury, and most of the crossings in Waltham. Train speeds at these locations were limited to 5-10 m.p.h. by the time freight service was discontinued in 1980. There are few sharp curves between the Stony Brook Junction site and Route 495. For purposes of analysis, it was assumed that with rebuilt track and modern crossing protection a top speed of 60 m.ph. would be feasible.

The fastest alternative analyzed would have stations in Hudson, Sudbury, and Wayland in addition to the Route 495 terminal. In Hudson, a new station site near Main Street at Kane Industrial Drive in the east side of town was assumed, because of insufficient land for parking at the old downtown site. (The new site is referred to in this report as Kane Drive.) The Sudbury station would be at about the same location as the old South Sudbury Station. A Wayland station at either the landfill or the Raytheon site would result in the same running times to Boston from stations further west. Weston already has three stations on the Fitchburg Line, and a new station on the Framingham Line is planned, so a station on the Central Mass. would attract few additional riders. The running time impact of such a station was examined, however.

With a top speed of 60 m.p.h. on the Central Mass., curve or crossing restrictions only in downtown Hudson, and intermediate stops only at Kane Drive, South Sudbury, Wayland, Waltham, and Porter Square, the shortest possible running time from Route 495 to North Station for a diesel locomotive and coaches would be about 53 minutes. From Kane Drive in Hudson, the time would be about 43 minutes. From South Sudbury, the time would be about 36 minutes. From Wayland, the time would be about 33 minutes from the landfill or about 32 minutes from the Raytheon site if only one of the two were served.

Table 3-1 compares the commuter rail running times to North Station estimated above with current scheduled bus times to Copley Square and with estimated auto driving times. At present there is no bus service from Berlin to Boston. The bus stop nearest to the I-495/Berlin Station site is the one in downtown Hudson. This is also the bus stop closest to the Kane Drive site. Scheduled bus times to Boston from downtown Hudson range from one hour and 15 minutes to Copley Square to one hour and 35 minutes to South Station. From South Sudbury to Boston, bus times range from 45 minutes to Copley Square to one hour and 10 minutes to Government Center. Times from Wayland are 5 minutes less than these. Thus, rail service would offer significant line-haul travel time improvements to Boston from towns directly on the Central Mass. route compared with present bus schedules.

Most passengers traveling by either bus or rail would need additional travel time between their trip origins and their boarding stops, and between their alighting stops and their final destinations. The differences in travel times between rail

Table 3-1
Comparison of Minimum Train Times to North Station
from Stations on Central Mass. Extension
With Times to Copley Square via Bus or Auto

<u>Station</u>	<u>Commuter Rail Extension</u>	<u>Present Scheduled Bus Time</u>	<u>Estimated Auto Time</u>
I-495/Berlin	53 minutes	NA	45 minutes
Hudson	43 minutes	75 minutes	49 minutes
South Sudbury	36 minutes	45 minutes	38 minutes
Wayland/Raytheon	32 minutes	40 minutes	32 minutes

Notes: Train time from rail station in east side of Hudson is compared with bus and auto times from downtown Hudson, which is three miles further from Boston.

Central Mass. times above allow for stops at Waltham Station and Porter Square. Additional station stops would result in longer running times.

Auto times are estimated because recent timing runs are not available for the complete driving paths to Boston from each origin.

and bus would vary from those discussed above depending on the specific origins and destinations of travelers.

The in-vehicle portion of most automobile commuting trips would begin at the actual trip origin and end at a parking facility somewhere near the final destination. The most commonly used route for auto trips from the Central Mass. corridor to downtown Boston is the Mass. Turnpike to Copley Square or South Station. The remaining drives over local streets to parking facilities can be viewed as analogous to final links from North Station to destinations for rail users. For purposes of analysis, rail times to North Station are compared below with driving times to Copley Square, although most commuters would have final destinations elsewhere.

Under average A.M. peak traffic conditions, the driving time to Copley Square would be about 49 minutes from downtown Hudson, 38 minutes from South Sudbury, and 32 minutes from Wayland Center. Thus, excluding distribution links to final destinations from Copley Square or North Station, Central Mass. service could provide travel times competitive with driving from these outer towns.

From Route 495 at Route 62 in Berlin to Copley Square, the A.M. peak driving time via Route 495 and the Mass. Turnpike is about 45 minutes. Although the

estimated rail time to North Station from an I-495/Berlin Station (53 minutes) would be longer than this, it would be close enough to be competitive.

Because of the speed restrictions in downtown Hudson, adding a stop there, designed mainly for walk-in traffic, would increase the running time from I-495 by only about 1 minute. Running times from stations further east would be unchanged. The running time to Boston from the downtown Hudson station would be about 50 minutes. Stopping at the old Weston Station site would add about 2 minutes to the running times from all other Central Mass. stations, because trains would otherwise be able to pass this location at full track speed.

Adding a stop at Brandeis/Roberts on the Fitchburg Main Line for Central Mass. trains would add about 1.6 minutes. Trains have to slow to 40 m.p.h. for a curve east of the station, reducing the net impact of making a stop there. Stops at Waverley and Belmont would each add 2 minutes. Omitting the Waltham Station stop would only save about 1.3 minutes, because trains have to slow to 30 m.p.h. on the single-track section through the station.

Between the potential Stony Brook Junction site and Clematis Brook, the former Central Mass. route through Waltham is one mile shorter than the Fitchburg Line. If Central Mass. trains were able to use this route at the historical top speed of 50 m.p.h., with no crossing restrictions and one stop in Waltham, the running time would be about 0.8 minute shorter than via the Fitchburg Line. Given the extra crossing protection requirements on this alignment and the less convenient Waltham station location, the time saving alone would be an insufficient reason to route trains this way instead of via the Fitchburg Line.

Levels of Service

The amount of service operated on existing MBTA commuter rail lines varies among routes. Service on a Central Mass. extension, as on other lines, would be adjusted over time on the basis of ridership experience. In the analysis, it was assumed that to capture the maximum market shares estimated in chapter 4, it would be necessary to operate service on a frequency similar to that now run on the inner half of the Fitchburg Line. On weekdays, that line currently has 16 round-trips, including five inbound A.M. peak Boston arrivals and five P.M. peak Boston departures. On Saturdays there are 8 round trips, and on Sundays there are 7.

Because of the low revenue-to-cost ratio calculated for this service level, as discussed in chapter 6, a lower level of service was also considered. Based on the service now provided on other MBTA commuter rail lines, the minimum acceptable frequency for Central Mass. service would be 8 weekday round-trips, with no Saturday or Sunday service.

Fares

MBTA commuter rail lines have a zone fare system. Zone limits are based nominally on mileage from Boston, but exceptions are made for reasons such as avoiding different fares at stations in the same town. Fare-payment options include single-ride or 12-ride tickets and monthly passes. (Survey results indicate that passes are used for an average of about 21 round-trips, or 42 rides, per month.) Senior citizens, children under the age of 12, high school or younger students, and persons with disabilities are eligible for half fares. Table 3-2 compares the cost per ride to Boston for existing mass transit services in the Central Mass. corridor with fares that riders on a commuter rail extension would pay. Fares from Central Mass. stations are assumed to be the same as those from stations at similar distances from Boston on the Fitchburg and Framingham/Worcester lines. These fares are described in greater detail below.

A Rte. 495/Berlin station would be in Zone 7, the same as the Littleton/Rte. 495 station.) The Zone 7 one-way full fare is \$3.75. Twelve-ride tickets are \$37.50, or \$3.13 per trip. Monthly passes are \$120.00, or \$2.86 per trip if used 42 times. The half fare is \$1.85.

A Hudson station would be in Zone 6, the same as South Acton. The Zone 6 one-way full fare is \$3.50. Twelve-ride tickets are \$35.00, or \$2.92 per trip. Passes are \$112.00, averaging \$2.67 per trip. The half fare is \$1.75.

A South Sudbury station would be in Zone 5, the same as stations in Concord and Framingham. The Zone 5 one-way full fare is \$3.25. Twelve-ride tickets are \$32.50, or \$2.71 per trip. Passes are \$104.00, averaging \$2.48 per trip. The half fare is \$1.60.

Stations at the Sudbury landfill or Wayland Raytheon sites would be in Zone 4, as are stations in Lincoln and Natick. A station at the Linde Air site would also be within the usual mileage range of Zone 4, although it would be in Sudbury. The Zone 4 one-way full fare is \$3.00. Twelve-ride tickets are \$30.00, or \$2.50 per trip. Passes are \$94.00, averaging \$2.24 per trip. The half fare is \$1.50.

A station in Weston would be in Zone 3, as are the present stations in Weston and Wellesley. The Zone 3 one-way full fare is \$2.50. Twelve-ride tickets are \$25.00, or \$2.08 per trip. Passes are \$82.00, averaging \$1.95 per trip. The half fare is \$1.25.

Comparison with Bus Fares

There is no bus service from Berlin to Boston for fare comparison. On the Gulbankian Bus Lines route, the fare from Hudson to Boston is \$4.00 one way. Ten-ride tickets are \$36.00, for an average cost of \$3.60 per trip.

On the Post Road Line bus route, the one-way fare from any stop in Sudbury is \$3.25 to Copley Square or Park Square, and \$3.40 to Government Center or South Station. Commuter tickets are sold at a rate of 11 rides for the price of 10, reducing the fares above to \$2.95 and \$3.09.

On the same route, the one-way fare from Wayland is \$3.00 to Copley Square or Park Square, and \$3.25 to Government Center or South Station. With commuter tickets, these fares are reduced to \$2.73 and \$2.95. The one-way fare from Weston is \$2.65 to Copley Square or Park Square, and \$2.85 to Government Center or South Station. With commuter tickets, these are reduced to \$2.41 and \$2.59. It should be noted that the Post Road Line receives an MBTA/EOTC subsidy but the Gulbankian route is unsubsidized.

Table 3-2
Cost per One-Way Trip to Boston for Selected Rail and Bus Fare Options

Station	Rail			Bus		
	One-Way	12-Ride	Monthly Pass	One-Way	Round-Trip	Multi-Ride
I-495/Berlin	\$3.75	\$3.13	\$2.86	NA	NA	NA
Hudson	\$3.50	\$2.92	\$2.67	\$4.00	\$4.00	\$3.60
So. Sudbury	\$3.25	\$2.71	\$2.48	\$3.25	\$3.25	\$2.95
Wayland	\$3.00	\$2.50	\$2.24	\$3.00	\$3.00	\$2.73
Weston	\$2.50	\$2.08	\$1.95	\$2.65	\$2.65	\$2.41

Note: Commuter rail passes provide free transfers to connecting MBTA services.

4. RIDERSHIP FORECASTS

Potential Commuter Rail Market Groups

Boston and Cambridge Work Trips

On the commuter rail lines now terminating at North Station, 92% of all final trip destinations are in either Boston or Cambridge, and 86% of these are home-to-work trips. Otherwise stated, home-to-work trips ending in these two cities account for 79% of all North Side commuter rail ridership. Over 93% of the home-to-work trips on North Side commuter rail lines are made on A.M. peak trains, defined as those scheduled to arrive at North Station between 6:30 and 9:30. Existing travel patterns in the corridor that would be served by a Central Mass. extension indicate that Boston and Cambridge work trips would likewise be the predominant source of ridership on such a line.

Within Boston, the commuter rail market share is highest for trips ending in Boston Proper, defined approximately as the area bounded by Massachusetts Avenue, the Charles River, Boston Harbor, Fort Point Channel, and the Southeast Expressway. The 1993 commuter rail survey found that 92% of the Boston work trip destinations of passengers on North Side commuter rail lines were in Boston Proper. In contrast, 1990 Census figures for all modes combined showed that only about 60% of all work trips to Boston from the cities and towns served by North Side commuter rail lines had destinations in Boston Proper. In 1993 the destinations of North Side rail work trips to Boston locations outside Boston Proper were concentrated most heavily in neighborhoods bordering on Boston Proper, with 85% going either to the Fenway/Parker Hill area, South Boston, Charlestown, or Allston/Brighton.

Other Destinations and Trip Purposes

Work trips account for a much higher proportion of commuter rail trips destined for Boston or Cambridge than of those destined for other locations. In the survey results, of the 8% of North Side rail trips with destinations outside Boston or Cambridge, only 43% (or 3.4% of the total ridership) were work trips.

Among North Side rail trips with destinations outside Boston or Cambridge, about 60% are interzone trips (i.e., trips between two stations on the same line, excluding North Station and stations in fare zone 1B). Interzone trip attractions vary among lines, however. Rather than simply applying factors for interzone travel from the Central Mass. extension corridor, an attempt has been made to identify interzone travel markets specific to this route, and to estimate the potential rail share of these markets.

Summary of Demand Estimation Method

Ridership forecasts for a Central Mass. extension were prepared using a manual forecasting method described below and in appendix E. Separate forecasts prepared using the CTPS regional demand model produced results somewhat lower than those prepared using the manual method. The model-based forecasts are discussed at the end of this chapter.

Total work travel from each town in the extension corridor to Boston Proper, the rest of Boston, and Cambridge was determined from the 1990 U.S. Census Journey-to-Work reports. Estimates of the shares of this travel that a Central Mass. extension could be expected to capture were made on the basis of information for existing commuter rail lines in the Census reports and in the 1993 MBTA commuter rail survey.

Non-work travel to Boston and Cambridge destinations via the Central Mass. extension was estimated by adding factors derived from survey results to the work trip estimates. Non-interzone ridership to destinations outside Boston and Cambridge was likewise estimated by applying factors to Boston and Cambridge ridership.

None of the probable station locations on the Central Mass. extension itself would be within walking distance of any major trip attractors. Therefore, interzone ridership between pairs of stations on the extension was assumed to be insignificant. The only other possible interzone trips to be served by Central Mass. trains would be between extension stations and Fitchburg Line stations in Waltham or Belmont. The number of such trips was estimated on the basis of inbound alighting counts and survey data for the Waltham and Belmont stations for Fitchburg Line trains. (Unless Central Mass. trains stopped at all four stations in Waltham and Belmont, some interzone trips would involve transfers between Central Mass. and Fitchburg Line trains.)

The Journey-to-Work figures used in making the ridership forecasts described above were taken from the 1990 Census. Estimates prepared by the Census Bureau indicate that overall population in the Central Mass. market area increased by about 5% between 1990 and 1996. As a result of economic conditions, however, overall Boston and Cambridge employment was essentially the same in 1996 as in 1990. Since work trips to Boston and Cambridge would be the predominant source of ridership on a Central Mass. extension, it was concluded that forecasts based on 1996 conditions would not differ significantly from those using the 1990 data. Ridership projections for the years 2010 and 2020 were made using factors based on a combination of data from the Census Bureau, the Metropolitan Area Planning Council, and the Massachusetts Institute of Social and Economic Research.

Ridership Forecasts by Trip Purpose and Destination

Based on the ridership forecasting methods discussed above and in appendix E, at current travel levels, a Central Mass. extension to I-495 with train frequency the same as that now run on the Fitchburg Line, but with unconstrained parking, would serve 1,295 inbound weekday passenger-trips. Of these, about 1,030 would be work trips to destinations in Boston or Cambridge, 165 would be non-work trips to Boston or Cambridge, and 100 would be trips to other destinations for all purposes. Of the latter, about 20 would be interzone trips ending in Waltham or Belmont; the rest would be trips through Boston or Cambridge to points not served directly by Central Mass. trains. Population and employment projections indicate that ridership would change little in future years, increasing to about 1,360 in the year 2020. (These totals do not include passengers carried between pairs of stations on the Fitchburg Line by Central Mass. trains.)

Estimated Ridership by Town of Origin

Table 4-1 shows the outer endpoints of trips in the 1996 demand estimates. Figures for individual towns for future years are not shown, because of the relatively small expected changes from 1996.

Table 4-1
1996 Estimated Weekday Inbound Ridership on Central Mass. Extension
to I-495/Berlin by Town of Origin

<u>Town</u>	<u>Trip Origins</u>
Wayland	425
Sudbury	340
Hudson	110
Bolton	35
Berlin	10
Marlborough	280
Clinton	50
Stow	40
Boylston	5
Total	1,295

Estimated Ridership for Extensions Only to Hudson or South Sudbury

Of the estimated 1,295 riders on a Central Mass. extension to I-495, only 100 (7.8%) would board at the I-495 station and 150 (11.6%) at Hudson. The segment between the Hudson and I-495 stations would account for about 30% of the length and capital costs of the extension, however, and that between South Sudbury and Hudson for about 25%. For this reason, consideration was also given to terminating the line at either Hudson (Kane Drive) or South Sudbury

instead of I-495. Based on the origins of passengers using an I-495 terminal, (Bolton, Berlin, Clinton, and Boylston) about half would be likely to use the station in Hudson instead if the line terminated there with no change in service frequency. This would reduce total weekday ridership to about 1,245. With a terminal at South Sudbury, most of the riders who would use a terminal at I-495 and those from Stow who would use a Hudson station would be unlikely to use Central Mass. service. Most of the trips originating in Hudson would divert to South Sudbury. This would result in weekday inbound ridership of about 1,160.

Effect of Reduced Level of Service

The ridership estimation method used to produce the numbers above assumes that service frequency would be similar to that now provided on the inner half of the Fitchburg Line. This is five peak and 11 off-peak round trips. The method is not calibrated directly for other frequency levels. To estimate ridership with less frequent service, the minimum acceptable service level for the Central Mass. was assumed to be the same as that on the outer end of Haverhill Line. This is four peak and four off-peak trips. Based on the proportions of peak and off-peak ridership on that line compared with other lines, weekday ridership on a Central Mass. extension would be about 18% lower at the reduced service level than with full service. For the shortest extension examined, to South Sudbury only, this would make the inbound weekday total 950 riders.

Estimated Diversions of Ridership from Other Transit Services

Currently, about 655 residents of cities and towns in the Central Mass. service area use MBTA commuter rail, express bus, or rapid transit lines for all trip purposes combined on weekdays. About 60 other residents of the area use private-carrier buses. These would be among the most likely travelers to shift to a Central Mass. extension. If all of them diverted, only 580 of the 1,295 Central Mass. riders at present levels would be new transit users. Future service improvements on the Fitchburg and Framingham/Worcester commuter rail lines will increase their attractiveness to residents of the Central Mass. service area. By the year 2020 this would reduce the number of Central Mass. riders who would not otherwise be transit users to around 520 per day.

With a terminal at Hudson, the 1996 weekday ridership total of 1,245 would include about 550 new transit riders. With a terminal at South Sudbury, the 1996 weekday ridership total of 950 would include about 420 new transit riders.

Other Ridership Impacts on Fitchburg and Framingham Lines

Impacts of Diversions of Parked Cars

The Central Mass. ridership estimates above include only boardings on the Central Mass. extension itself. As a result of diversions to stations on the

extension, about 140 parking spaces would be vacated at Fitchburg Line stations where ridership is now severely constrained by parking capacity. Journey-to-Work data for towns served by these stations indicates that even with competition from the Central Mass. there would still be enough demand to refill the vacated spaces. Most of them would be taken by passengers who currently drive to Alewife Station or Riverside, rather than by new transit users, however.

Parking by potential Central Mass. riders at Framingham Line stations is more dispersed than parking at Fitchburg Line stations. Framingham Line parking capacity problems attributable to these riders will be relieved by planned establishment of additional stations and expansion of existing ones on that line.

Impacts of Central Mass. Trains Serving Fitchburg Line Stations

As described in chapter 3 of this report, Central Mass. trains would most likely operate over the Fitchburg Line between North Station and a new junction near Route 128 on the border of Waltham and Weston. The Porter Square, Belmont, Waverley, Waltham, and Brandeis/Roberts stations are located on this segment. Central Mass. trains could stop at some or all of these stations. This could be done either to increase the frequency of service at these stations or to allow Fitchburg Line trains to omit them in order to reduce running times to Boston from stations further west. Both strategies were analyzed using methods described in appendix E, with findings as summarized below.

The largest ridership increases would result from stopping all Central Mass. trains at all Fitchburg Line stations from Brandeis/Roberts east, with no reduction in service by other trains. At the minimum service level assumed for the Central Mass., this would attract about 125 additional weekday inbound riders to these stations. Of these riders, about 40 would be new transit users. With the maximum service level assumed for the Central Mass. about 200 additional weekday inbound riders would use the inner Fitchburg Line stations. Of these riders, about 95 would be new transit users.

Providing all service at Waltham, Waverley, and Belmont with Central Mass. trains would attract only 25 to 30 new inbound boardings per day at stations west of Brandeis/Roberts. Most of these would be diverted from other transit services. It was assumed that trains on both routes would serve Brandeis/Roberts and Porter Square because of their importance as alighting stations and the need to provide transfer points for interzone riders destined for Waltham, Belmont or Waverley. Because of the more frequent service, inbound boardings at Brandeis/Roberts and Porter Square would increase by a total of 65 to 115, depending on the level of Central Mass. service operated. This would include about 35 new transit riders at the low-end service level and 75 at the high end. Combined with gains at the outer stations, overall Fitchburg Line boardings would increase by about 90 to 145.

Although this alternative of providing faster service to Fitchburg Line stations west of Waltham would attract fewer riders than increasing the number of trains at inner stations, the former option would generate more new revenue. The reason for this is that new riders boarding at outer stations would pay higher average fares. Also, for riders shifting to the Fitchburg Line from other transit services, the increase in fares paid compared with those on the previous services would be smaller at inner-zone stations.

Estimated Weekend Ridership

Weekend ridership is more difficult to predict than weekday ridership, because weekend travel consists largely of non-repetitive trips for purposes such as shopping, sightseeing, attending sporting events, etc. For the commuter rail system as a whole, ridership averaged 29.2% as high on Saturdays as on weekdays, and 17% as high on Sundays as on weekdays in April 1994. With similar ratios, Central Mass. trains could be expected to carry about 300 inbound riders on Saturdays and 170 on Sundays. These would be much lower totals than are currently carried on any MBTA commuter rail route on a typical weekend. For this reason, the Central Mass. might have very limited weekend service or none at all.

Model-Based Ridership Forecast

In addition to the demand estimates produced by the methods described above and in appendix E, ridership on a Central Mass. extension in the year 2020 was forecast using the CTPS Interim Regional Model. This model is currently being used for all CTPS highway and transit studies within the region.

The results indicated that in the year 2020 a Central Mass. extension to I-495 would serve approximately 1,100 riders per day, or about 20% fewer than the manual-forecast figure of 1,360 for the same year.⁷ Most of the absolute difference of 260 is in the number of new transit riders predicted (310 from the model versus 520 from the manual forecast). The discrepancies are attributable mainly to different assumptions regarding the effect of parking constraints on the commuter rail share of travel to Boston and Cambridge.⁸ With ridership at the level predicted by the model, the revenue-to-cost ratio of a Central Mass. extension would be even lower than shown in chapter 6.

⁷Both of these figures include only ridership at stations on the extension itself.

⁸Parking constraints are difficult to represent in the regional model. Therefore, it is also difficult for the model to account for the effects of relaxing those constraints.

5. CAPITAL COSTS

The main capital costs for commuter rail extensions consist of construction or upgrading of tracks, signals, bridges, and crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. A Central Mass. extension would use a rail line that has been out of service since 1980 and would need to be almost entirely rebuilt. Capital costs are summarized below by category. All of the cost figures are approximations.

Track and Signals

Most of the rails and ties on the Central Mass. line are still in place, but they were in poor condition even before service was discontinued. Normal weathering since then has caused further deterioration of the ties and roadbed. The track structure would have to be entirely replaced for future service. In the past, the only signals on the Central Mass. were at the approaches to junctions with other rail lines, so a completely new signal system would be needed.

From a connection with the Fitchburg Line at Stony Brook Junction (between Brandeis/Roberts and Kendal Green) to I-495 in Berlin, the length of a Central Mass. extension would be 18.4 miles. The cost of new track and signals for this distance would be \$47,710,000. An extension only to Kane Drive in Hudson would be 12.7 miles long. For this distance, the cost of track and signals would be \$33,045,000. An extension only to South Sudbury would be 8.0 miles long. For this distance, the cost of track and signals would be \$20,695,000.

Connection with Fitchburg Line at Stony Brook

As discussed in chapter 3 and appendix B of this report, when last operated the Central Mass. line diverged from the Fitchburg Line at Clematis Brook Station in Waltham, followed a separate alignment west through that city, and crossed over the Fitchburg Line on a bridge near the border of Waltham and Weston. There was never a connection between the two lines at this crossing (referred to here as Stony Brook Junction), but from an operations standpoint, a connection there would be preferable to Clematis Brook.

Because of the difference in elevation between the two rail lines, a Stony Brook connection would require constructing a sloping fill at least 1,000 feet long. The possible alignment for such a fill would be constrained by a rock quarry over 100 feet deep in the southeast quadrant of the crossing and by an oil tank farm in the northeast quadrant. The angle of the crossing as well as topography and present land use would rule out a connection in either of the western quadrants.

A preliminary estimate of the cost of this connection, including grading, track work, and signals and crossovers on the Fitchburg Line, is \$3,000,000. For comparison, the cost of rebuilding the former Central Mass. alignment between

Stony Brook Junction and Clematis Brook, including track and signal work, crossing protection, fencing, and one station, would be about \$11,700,000.

Road Crossing Surface, Lights, and Gates

Between Stony Brook Junction and I-495, the Central Mass. right-of-way has 26 grade crossings of public roads and at least 5 crossings of private roads. When service was last operated, the public crossings were protected by automatic flashing lights but not gates. The crossing protection devices have all been either removed or vandalized beyond repair. Future service would require new lights and gates at all of the public crossings; improvement of the road crossing surfaces would also be required. The cost of all of this work would be \$3,415,000.

The crossings are most heavily concentrated on the west end of the line. Thirteen of the public crossings (half of the full extension total) and 1 of the private crossings are between Main Street at Kane Drive in Hudson and I-495. Another 5 public crossings and 1 private crossing are between South Sudbury and Main Street. For an extension only as far as Kane Drive, the cost of crossing surface and protection improvements would be \$1,705,000. For an extension only as far as South Sudbury, the cost of crossing improvements would be \$1,080,000.

Fencing

At present, most of the Central Mass. right-of-way is unfenced. For safety, fencing would be needed at all locations where developed land adjoins the right-of-way. A preliminary inspection indicates that this would require fencing of about ten miles of the route between Stony Brook Junction and I-495, at a cost of \$710,000. With an extension to Kane Drive in Hudson only, the cost would be \$500,000. With an extension to South Sudbury only, the cost would be \$315,000.

Bridges

The Central Mass. line crossed two roads on bridges. Both of these bridges were in Hudson, in the segment west of Kane Drive, and both have been removed. Five rivers or streams were crossed on long wooden-pile trestles. Although these are still in place, they are in poor condition and should be replaced for future rail service. Three of these are in Hudson west of Kane Drive and one is between Kane Drive and South Sudbury.

Eight roads crossed the Central Mass. right-of-way on bridges. Two of these bridges in Hudson (both west of Kane Drive) and one in Weston have been removed and replaced with solid fill. The other five road bridges are still in place and do not appear to require any upgrading.

The total cost of rebuilding all of the track bridges and the three filled-in road bridges would be \$17,370,000. With an extension only as far as Kane Drive in

Hudson, this cost would be reduced to \$6,690,000. With an extension only as far as South Sudbury, the cost would be reduced to \$2,975,000.

The one water crossing east of South Sudbury is that of the Concord River, on the border of Wayland and Sudbury. The east end of this bridge is at a grade crossing with U.S. Route 20. Because of heavy road traffic, replacement of this crossing with a railroad bridge built as an extension of the new Concord River bridge should be considered. The cost of such an extension is not included in the totals given above, however.

Station Platforms and Shelters

The I-495, Hudson, and Wayland stations would be at locations where there have not previously been stations, so entirely new facilities would be needed. South Sudbury still has a low-level platform but lacks a shelter, access facilities for persons with disabilities, and a parking lot.

For reasons discussed below, the longest train required to meet demand on the Central Mass., including capacity for riders boarding east of Stony Brook Junction, would be one consisting of five single-level cars. For scheduling efficiency, however, it is desirable to allow equipment sets to shift between routes at North Station. For this reason, Central Mass. platform lengths should be consistent with train lengths on other North Side lines. Current MBTA construction standards call for eight-car platforms at commuter rail stations, so it is assumed that Central Mass. stations would have eight-car platforms.

A Central Mass. extension to I-495 would have four stations. Based on the most recent construction costs for eight-car high-level platforms, including benches, shelters, and lighting but excluding land acquisition, the cost of four stations would be \$3,215,000. An extension only to Kane Drive in Hudson would have three stations, at a cost of \$2,410,000. An extension only to South Sudbury would have two stations, at a cost of \$1,610,000.

Parking

Based on the demand forecasts in chapter 4 and the likely distribution of access modes, a total of 890 parking spaces would be needed to meet average weekday demand on the Central Mass. extension to I-495 at 1996 ridership levels. (This includes an allowance for day-to-day ridership variation.) The Berlin/I-495 and Hudson stations would each need 90 spaces. South Sudbury would need 300 spaces and Wayland would need 410. The cost of providing all of this as new surface parking would be \$2,670,000. At the Raytheon site in Wayland, some reduction in this cost could be achieved through reuse of existing parking lots.

If the extension terminated at Kane Drive in Hudson, parking capacity would need to be expanded to 150 there, but no changes would be needed at the other

two stations. This would lower the capital cost for parking to \$2,580,000. With an extension only to South Sudbury and a reduced service level, the South Sudbury station would require 345 spaces and Wayland would need 335. Therefore, the total parking cost for this alternative would be \$2,040,000.

Layover Facility

As discussed in chapter 3, the extension should include a layover facility to minimize operation of non-revenue train-miles. The cost of a facility of the size needed for this line would be about \$1,000,000.

Rolling Stock

At the projected 1996 ridership level on a Central Mass. extension to I-495, the maximum load on an individual train (excluding boardings at stations on the Fitchburg Line) would be about 360. To provide seats for all of these passengers, trains of either two double-deck or three single-level coaches would be sufficient. At the estimated running times, an extension to either I-495 or Hudson would require three train sets for five A.M. peak trips. Currently locomotives cost about \$2,200,000 each and double-deck coaches about \$1,600,000 each. The cost of three locomotives and six double-deck coaches would be \$16,200,000.

Terminating service at South Sudbury would not reduce running time enough to allow fewer train sets to be used if service frequency were the same as assumed for an I-495 terminal. Reducing the number of peak-period trips from five to four with a South Sudbury terminal would allow two train sets to provide all service. This, combined with lower ridership on the shortened route, would reduce the capital cost requirement for rolling stock to \$10,800,000.

The most heavily used A.M. peak train on the Fitchburg Line has about 135 passengers boarding at all stations in Waltham and Belmont combined. This is equal to 73% of the seating capacity of one double-deck coach or 110% of that of one single-level coach. If service were reconfigured to have Central Mass. rather than Fitchburg Line trains pick up these passengers, cars could be reassigned from Fitchburg Line trains to Central Mass. trains to provide the needed capacity. Therefore, the cost of these cars is not included in the Central Mass. rolling stock requirement. (As discussed in chapter 4, the reduction in running times from Fitchburg Line stations west of Waltham would attract only about 25 additional A.M. peak boardings at those stations. Only 5-10 of these would be on any individual trip.)

Summary of Capital Costs

The costs discussed above for a Central Mass. extension between a connection with the Fitchburg Line at Stony Brook Junction and Route I-495 in Berlin total \$103,315,000. For an extension only to Kane Drive in Hudson, the cost would be

\$72,910,000. For an extension only to South Sudbury, the cost would be \$47,475,000 using two train sets or \$52,875,000 using three sets. These costs are summarized in Table 5-1. It should be noted that they are based on a preliminary examination of the facilities needed, rather than on detailed engineering studies.

Table 5-1
Summary of Capital Costs for Central Mass. Extension

<u>Item</u>	<u>To I-495/Berlin</u>	<u>To Hudson</u>	<u>To South Sudbury</u>
Track and Signals	\$47,710,000	\$33,045,000	\$20,695,000
Connection to Fitchburg Line	3,000,000	3,000,000	3,000,000
Grade Crossing Surface, Lights, Gates	3,415,000	1,705,000	1,080,000
Fencing	710,000	500,000	315,000
Bridges	17,370,000	6,690,000	2,975,000
Station Platforms and Shelters	3,215,000	2,410,000	1,610,000
Parking	2,670,000	2,580,000	2,040,000
Layover Facility	1,000,000	1,000,000	1,000,000
10% Contingency Factor	7,910,000	5,095,000	3,270,000
Rolling Stock	<u>16,200,000</u>	<u>16,200,000</u>	<u>10,800,000</u>
Total	\$103,200,000	\$72,225,000	\$46,785,000

6. OPERATING COSTS AND REVENUES

Operating Costs

Operating costs for a Central Mass. extension would be determined primarily by the length of the route and the number of trips operated each day. A terminal at I-495 in Berlin would be 31.1 miles from North Station. With the same service frequency as currently operated on the inner half of the Fitchburg Line, there would be 16 round-trips on weekdays, 8 on Saturdays, and 7 on Sundays. At the current average operating cost of \$39.50 per train-mile, the annual operating cost for this alternative would be \$12 million. (This assumes that there would be a layover facility at the outer terminal, so that no non-revenue miles would be needed.)

An extension only to Kane Drive in Hudson with the same service frequency specified above would reduce train-miles by 18% compared with an I-495 terminal, resulting in an annual operating cost of \$9.8 million. An extension only to South Sudbury with the same service frequency specified above would reduce train-miles by 33% compared with an I-495 terminal, resulting in an annual operating cost of \$8 million.

The lowest operating-cost strategy examined would consist of service to a South Sudbury terminal with a substantially lower service frequency than specified above. At present, the lowest level of weekday service operated on any North Side commuter rail line is 8 round trips, on the outer end of the Haverhill Line. Most, but not all, MBTA commuter rail lines currently have weekend service.⁹ The ridership forecasts in chapter 4 indicate that the Central Mass. Line would carry significantly fewer weekend riders than any of the existing lines. Therefore, service might be operated on weekdays only.

With a terminal at South Sudbury, weekday service at the same level as that operated to Haverhill, and no weekend service, the annual operating cost for the Central Mass. extension would be \$3.3 million.

Operating Revenues

Under the present fare structure, at the 1996 weekday ridership level estimated in chapter 4 for an I-495 extension and with weekend ridership in typical proportion to this, annual revenue from passengers using Central Mass. stations would be \$1.9 million. The extension would, however, result in a net decrease of about \$0.4 million per year in revenue collected on other MBTA services. (This

⁹On the North Side, the Ipswich Line north of Beverly has service on Saturdays but not Sundays. On the South Side, there is no weekend service on the Fairmount and Stoughton lines, or on the Providence Line beyond South Attleboro. The Needham Line has service on Saturdays but not Sundays.

takes into account net diversions to the Central Mass. and new riders attracted to the Fitchburg Line as the result of service provided by Central Mass. trains at inner stations.) Therefore, incremental revenue for the MBTA system would be \$1.5 million per year.

With a terminal at Kane Drive in Hudson and the maximum assumed service frequency, total Central Mass. fare revenue would be \$1.8 million. Of this, \$1.4 million would represent incremental system revenue.

With the minimum-cost operating strategy of a South Sudbury terminal, reduced weekday service, and no weekend service, annual Central Mass. revenue would decrease to \$1.2 million, of which about \$1 million would be incremental system revenue.

Comparisons of Revenues and Costs

With the full extension to I-495 and the maximum assumed levels of weekday and weekend service, the incremental annual revenue would equal 12% of the annual operating cost. This would be far below the MBTA's average cost-recovery level. With a Hudson terminal, the ratio would be only slightly higher, at 14%.

For an extension only to South Sudbury with the minimum assumed weekday service level and no weekend service, the incremental annual revenue would equal 27% of the annual operating cost. Although this would be much better than the ratio for an I-495 extension, it would still be below the system average.

Assuming constant costs and fare structure, projected ridership changes between the years 1996, 2010, and 2020 would result in even lower revenue-to-cost ratios than those shown above. The reason for this is that service improvements on other lines would reduce the proportion of Central Mass. riders who would not otherwise be MBTA users.

For the full extension to I-495, the capital cost of \$103,200,000 divided by the 580 new transit users attracted to the Central Mass. itself would make the cost per new user \$177,931. For an extension to Hudson only, the figure would be \$131,318. For an extension to South Sudbury with a reduced level of service, the capital cost per new rider would be \$111,393. Inclusion of new transit riders attracted to the Fitchburg Line as a result of Central Mass. service would lower each of these averages by about 10%. In any case, all three alternatives would be among the most costly per new transit rider of all MBTA commuter rail extensions analyzed recently.

Table 6-1 summarizes the costs and revenues of a Central Mass. extension.

Table 6-1
Cost and Revenue Comparisons
for Central Mass. Extension

<u>Item</u>	To <u>I-495/Berlin</u>	To Hudson	To South <u>Sudbury</u>
Annual Operating Cost	\$11,995,000	\$9,830,000	\$3,315,000
Incremental Fare Revenue	\$1,445,000	\$1,375,000	\$910,000
Incremental Revenue/Operating Cost	0.121	0.140	0.274
Capital Cost/New Transit Rider	\$177,931	\$131,318	\$111,393

Note: South Sudbury figures are based on reduced weekday service, with no weekend service

7. OPERATIONAL ISSUES

Impact of Central Mass. Extension on Other Commuter Rail Services

Impact on Fitchburg Line Service as Currently Operated

Trains from a Central Mass. extension would have to use the tracks of the Fitchburg Line between North Station and either Clematis Brook in Waltham or a new Stony Brook Junction. The Fitchburg Line is mostly double-tracked in this area, but there is a single-track segment 0.6 mile long in Waltham, from just west of Waltham station to just east of Newton Street. This would have a direct effect on the scheduling of Central Mass. trains using a Stony Brook connection and could indirectly affect schedules of trains using a Clematis Brook connection.

The current weekday schedule of passenger trains on the Fitchburg Line has 16 trips in each direction on the segments that would be shared by Central Mass. trains. The closest scheduled spacing of inbound trains at Waltham Station is 28 minutes. The closest scheduled spacing outbound is 12 minutes. Without the constraint of the single-track segment, there would be little difficulty in finding time slots for Central Mass. trains at any likely service frequency. The single track would reduce the flexibility in selecting times for Central Mass. trains but would not present an insurmountable obstacle.

Of the 16 inbound trains on weekdays, 7 are scheduled to pass Waltham Station within 10 minutes or less of outbound trains. For reliability, no attempt should be made to schedule additional trains between the inbounds and outbounds in such cases. Most of the close meets at Waltham Station are results of the same trains having to meet others at ends of single-track sections further west, so they cannot easily be changed.

At one time, the single-track segment in Waltham was double-tracked, but the only platform at Waltham Station was on the outbound side. Inbound passengers had to walk across the outbound track to board or alight through left-side train doors. This made it necessary to schedule service so that inbounds and outbounds would not be in the station at the same time, so the effect was similar to that of single track. The present Waltham Station has separate inbound and outbound platforms on opposite sides of Moody Street, but both of these are on the north side of the track. Elimination of the bottleneck would require not only restoration of a second track but also a major reconfiguration of the station. Any such reconfiguration should be made consistent with the city of Waltham's long-range goal of eliminating the grade crossings of Moody and Elm streets.¹⁰

¹⁰For a more detailed discussion of this issue, see Central Transportation Planning Staff, *Evaluation of the Moody and Elm Street Railroad Grade Crossings in Waltham, Final Report* (November 1979).

Impact on Future Fitchburg Line Express Service

At present, inbound A.M. peak service on the Fitchburg Line consists of four trips originating at Fitchburg and one originating at South Acton. The South Acton train and three of the Fitchburg trains stop at every station between their starting points and North Station.¹¹ The other Fitchburg train makes all stops from Fitchburg to Lincoln, then omits all stops from there to Porter Square except Waltham. Outbound P.M. peak service provides similar coverage.

For the 1994 Program for Mass Transportation (PMT), new peak-period express service for the Fitchburg Line was analyzed. In the morning, five trains would originate at Fitchburg, make all stops from there to Concord, then run nonstop to Porter Square. Five other trains would originate at Littleton/495 and serve all stops from there to North Station. Stations from Littleton/495 to Concord would be served by both local and express trains. Outbound P.M. peak service would have a similar pattern.

The analysis found that this express service, combined with faster speed limits, would attract 570 additional inbound riders per weekday to the Fitchburg Line in the year 2020, including 480 new transit users. The capital cost per new transit user was found to be \$76,262.

Under this express service alternative, the number of peak-direction trains using the Fitchburg Line tracks through Waltham, Belmont, and Cambridge in peak hours would increase by five. This would be the same as the maximum number of Central Mass. trains that would be added to the same portion of the line under the alternatives examined in the present study. More detailed analysis would be needed to determine whether the line could accommodate Central Mass. trains in addition to both local and express Fitchburg Line trains.

As discussed in chapter 4, a possible operating strategy for Central Mass. trains would be to have them provide most of the service at Waltham, Waverley, and Belmont on the Fitchburg Line. Trains from Fitchburg and South Acton would still need to stop at Brandeis/Roberts for the benefit of passengers destined there or requiring transfers to reach stations no longer served directly. (Fall 1994 counts showed 48 A.M. peak inbound alightings at the four stops in Waltham and Belmont, of which 24 were at Brandeis/Roberts.) This pattern would allow Fitchburg Line trains to run faster than at present but would represent a much smaller improvement than the express service examined in the PMT.

As discussed in chapter 4 and appendix E, omitting stops at Waltham, Waverley, and Belmont alone would reduce running times to Porter Square and Belmont by about 4.5 minutes. Based on travel time elasticity formulas, this would attract

¹¹The lightly patronized Silver Hill Station in Weston is not served by the South Acton train nor by the first of the three Fitchburg locals.

only about 50 additional A.M. peak inbound riders from stations west of Brandeis/Roberts, assuming unlimited parking. Most of these would be diverted from other transit services. The increased service frequency at Brandeis/Roberts and Porter Square would add another 30 riders, but only 10 would be new transit users. Therefore, operation of Central Mass. trains should not be regarded as a substitute for the PMT express service option for the Fitchburg Line.

Impacts on Intercity Passenger Service

No intercity passenger service is operated on the Fitchburg Line at present, and none is under consideration. The only location where Central Mass. trains would share facilities with intercity trains would be at North Station. Impacts there are discussed in the final section of this chapter.

Impacts on Freight Service

There is no through freight train service on the sections of the Fitchburg Line that would be used by Central Mass. trains. Local freight service is operated by the Springfield Terminal Railway Company, but it generally does not exceed one train per day in each direction. Therefore, no significant conflicts between scheduling requirements of Central Mass. trains and Fitchburg Line freight trains would be expected.

It is unlikely that freight service would be operated on the Central Mass. line itself. Most of the businesses that used freight service on the line in the past have closed or relocated. Future industrial development potential in the Central Mass. corridor appears insufficient to sustain a viable rail freight operation. If freight service were to be provided on the line, the MBTA, as owner, would have the right to restrict times of freight trains to prevent conflicts with passenger service.

Between Stony Brook Junction and Berlin, the only other active rail line intersected by the Central Mass. would be the Conrail Lowell Secondary Track. This line crosses the Central Mass. at grade at South Sudbury. Freight trains are run as needed on the Lowell Secondary to deliver building supplies to the Saxonville Lumber Company's warehouses near the South Sudbury Station site. The track layout requires that these freight trains pass over the crossing of the Central Mass. in the course of switching cars in and out of the lumberyard sidings. It would be necessary to impose a schedule on the freight operation to prevent conflicts with Central Mass. service. Interlocked signals would also be needed to alert train crews on each line of approaching trains on the other line.

Impacts at North Station

At present, North Station has 10 tracks served by five island platforms. All of these were recently extended by about three carlengths in conjunction with the

construction of the new FleetCenter sports arena, which is located above the extensions. The platforms are not all the same length, but most of them have capacities of at least nine cars. This would greatly exceed the maximum train length required on the Central Mass. At present, the 10 tracks are used by trains from four lines, three of which have multiple outer turnback points. Amtrak intercity service to Portland, Maine, expected to start in late 1997, will also use North Station, but only three to five round-trips per day are anticipated initially.¹² Portland service would be provided mostly for non-work travel, so most of the trains would be in North Station during off-peak hours.

The design of FleetCenter provides for one additional platform serving two additional tracks, but completion of these would require the taking of part of the Mass. General Hospital employee's parking lot, which now borders on Track 10. Unless the frequency of service on the existing lines increases greatly, the addition of Central Mass. service should not result in any capacity problems at North Station itself, even without the two extra tracks.

A greater capacity constraint at North Station is imposed by the Charles River crossing just beyond the outer ends of the platforms. There, the 10 station tracks are reduced to four to cross two double-track drawbridges. In the past there were two additional bridges, but these have been removed and the Spaulding Rehabilitation Hospital now occupies the former site of their southern approach. Therefore, present and future schedules must allow for moving all trains on all routes through this four-track section.

The Charles River is a navigable waterway at the North Station drawbridges but is now used almost exclusively by excursion boats and small pleasure craft. Notices on the bridges state that they will not open for water traffic during weekday peak hours, so any boats that will not clear the closed bridges must wait. (The bridges are upstream of the Charles River Dam, which maintains constant clearance of about seven feet beneath them.) Operation of Central Mass. trains would result in no additional conflicts with water traffic during peak hours. Off-peak trains could be subjected to some delays, when the bridges are opened for boats, and conversely, boats could experience additional delays waiting for the bridges to reopen after Central Mass. trains pass.

¹²Stone & Webster Engineering Corp., *Statewide Rail Passenger Service Study: Technical Appendix: Report on Passenger Needs: Boston-Portland-Brunswick Corridor*, Prepared for State of Maine Department of Transportation (October 1990).

8. ENVIRONMENTAL AND COMMUNITY IMPACTS

Impacts on Air Quality

Air quality impacts of transit projects are typically calculated on the basis of expected changes in vehicle miles of travel (VMT) resulting from the project. For the Boston region, the automobile-generated pollutants of greatest concern are carbon monoxide (CO), nitrous oxides (NOx), and volatile organic compounds (VOC). Based on the present travel modes of the expected users of Central Mass. rail service, an I-495 extension would reduce automobile vehicle miles of travel by about 32,650 per weekday. An extension only to Kane Drive in Hudson would reduce VMT by about 30,750 per weekday. An extension only to South Sudbury with reduced frequency would reduce VMT by about 21,050 per weekday. The associated improvements in air quality would be as shown in Table 8-1.

Table 8-1
Central Mass. Extension
Reduction in Average Weekday Auto Emissions

	I-495/Berlin <u>Terminal</u>	Hudson <u>Terminal</u>	So. Sudbury <u>Terminal</u>
VMT Reduction	32,650	30,750	21,050
CO Reduction	327.7 kg	308.5 kg	211.2 kg
NOx Reduction	55.4 kg	52.1 kg	35.7 kg
VOC Reduction	30.6 kg	28.8 kg	19.7 kg

At the same time, however, the diesel locomotives used on trains would add emissions to the air. In addition to CO, NOx, and VOC, particulate matter (PM) is of concern for diesel vehicles. For extensions to I-495 or Hudson with 16 round-trips per day or an extension only to South Sudbury with 8 round-trips per day, locomotive emission increases would be as shown in Table 8-2.

Table 8-2
Central Mass. Extension
Increase in Average Weekday Train Emissions

	I-495/Berlin <u>Terminal</u>	Hudson <u>Terminal</u>	So. Sudbury <u>Terminal</u>
CO Increase	44.9 kg	37.4 kg	16.1 kg
NOx Increase	491.9 kg	406.2 kg	170.2 kg
VOC Increase	15.8 kg	13.2 kg	5.7 kg
PM Increase	6.5 kg	5.3 kg	2.2 kg

The net impact of the reduction in auto emissions and increase in locomotive emissions would be as shown in Table 8-3. As can be seen from the table, extensions to any of the three terminals analyzed would result in overall reductions in CO levels and VOC levels but increases in NOx and particulate matter levels.

Table 8-3
Central Mass. Extension
Net Change in Average Weekday Emissions

	I-495/Berlin <u>Terminal</u>	Hudson <u>Terminal</u>	So. Sudbury <u>Terminal</u>
CO change	-282.7 kg	-271.1 kg	-195.1 kg
NOx change	+436.5 kg	+354.0 kg	+134.6 kg
VOC change	-14.8 kg	-15.6 kg	-14.0 kg
PM change	+6.5 kg	+5.3 kg	+2.2 kg

Impacts on Water Resources

A Central Mass. extension would use an existing railroad right-of-way which has been inactive since at least 1980. Some changes in cuts and embankments have been made where bridges have been removed. Reactivation of service would return the grade to its pre-abandonment form at most locations.

The Central Mass. right-of-way is generally graded for only one track. There were formerly passing tracks at the old Weston, Wayland, and South Sudbury station sites. Optimal passing track locations for future service would depend on the desired schedule; they would require a more detailed operating analysis than was performed for this study. It appears, however, that passing tracks could be provided without adversely affecting any water resources.

The Central Mass. crossed five rivers, ponds, or other bodies of water on long open-deck wooden trestles. Because of the age and condition of these structures, the capital cost estimates in chapter 5 assume that all of them would be replaced. The costs are based on closed-deck bridges, which would be provided with drainage systems to prevent pollutants such as oil and brake dust from being dropped in the water by trains. Pollutants dropped on other sections of the railbed by trains would be in low concentrations and would be unlikely to migrate to wetlands, waterways, or groundwater in significant volumes. Runoff of pollutants dropped in parking lots by autos would be a more likely problem, which would have to be dealt with by use of appropriate drainage systems and lot maintenance strategies.

The I-495/Berlin station site would be next to a swamp. Provision of adequate parking there would probably require some filling of these wetlands. At South

Sudbury, the only undeveloped parcels large enough for necessary parking also include wetlands. Most of the Saxonville Lumber site is already paved, so replacing it with a commuter parking lot with drainage improvements would not adversely affect water resources.

The Kane Drive, Linde Air, Sudbury landfill, and Wayland Raytheon sites are all near wetlands. Construction of stations at any of these sites would provide an opportunity to improve wetlands impacts compared with those of past industrial uses, however.

Impacts on Community and Cultural Resources

This impact category covers changes that would occur to historic buildings, sites, or districts, to archeological sites, to parks or open spaces, and to buildings or resources that are important to the expression of cultural values, such as schools, churches, and monuments.

The Central Mass. right-of-way does not pass close to any sites that meet this definition in Weston, Sudbury,¹³ or Berlin, but would impact some sites in Wayland and Hudson. Specifically, at Wayland Center the line passes through the town historic district. Buildings within this district include the Heard House, which serves as headquarters and museum of the town historical society, and the former railroad station, which is owned by the town and used as a nonprofit gift shop. The town library is also near the right-of-way. In Hudson, the Central Mass. runs past two churches (including one with parking that currently encroaches on the right-of-way) and an elementary school. All of these are in the segment between Kane Drive and I-495.

Traffic Impacts on Major Arterial Routes

The reductions in vehicle miles of auto travel resulting from a Central Mass. extension would be distributed over many different routes. The greatest reduction at any individual location would occur on Route 20 at the Wayland/Weston town line. With a terminal at I-495 or in Hudson, the daily reduction at this point would be about 485 cars in each direction. The highest concentration of these would occur between 8:00 and 8:30 A.M., when about 135 cars would be removed. This would be about 17% of the eastbound traffic on the road in this interval. A South Sudbury terminal with reduced service would have a slightly lower impact in the peak half hour. The daily reduction would be about 400 vehicles in each direction.

¹³Although there was formerly a Wayside Inn Station in Sudbury, the historic inn itself is over a mile from the nearest point on the rail line.

Traffic Impacts of Station Access

With stations at I-495, Kane Drive in Hudson, South Sudbury, and Wayland, the most heavily used of the four, regardless of specific location, would be the one serving Wayland. At this station, with the maximum service level examined, the most heavily used train would have about 180 boardings. About 150 of the passengers for this train would use some form of auto access. In the final minutes prior to train departure, auto arrivals would average about 16 per minute, but not all of these would approach from the same direction. A station at the Raytheon site in Wayland would be accessed both from Route 20 and from Route 27. This would divide approaching traffic there among four directions so impacts on other traffic using the same roads would be small.

At South Sudbury, the maximum auto arrival rate would be around 10 per minute. At I-495 or Kane Drive, the maximum rate would be about 3 per minute.

Grade Crossings

The Central Mass. alignment from Stony Brook Junction to I-495 has 26 grade crossings of public roads in 18.4 miles, or an average spacing of 0.7 mile. The greatest concentration of these is between Kane Drive in Hudson and I-495, where there are 13 crossings in 5.6 miles (an average spacing of 0.43 mile).

Two of the busiest crossing locations are on Route 20—on the Wayland border and just east of South Sudbury. Elimination of the crossing on the Wayland border appears to be feasible through elevation of the track in conjunction with replacement of the adjoining trestle over the Concord River. The cost of this has not been included in chapter 5, however. (Because of proximity to the river, depression of the track at Route 20 would not be feasible.)

Traffic at each grade crossing of Route 20 would be stopped for about 45 seconds for each train. With schedules similar to those on the Fitchburg Line, there would be three to four trains per hour in both directions combined during peak hours. The total delay per hour to highway traffic at each crossing would be less than the total hourly delay at any of the present signalized intersections along Route 20.

At Wayland Center, state routes 27 and 126 are crossed at grade in close succession just east of the old Wayland Station site. Elimination of these crossings by elevating them would be more compatible with an elevated Route 20 crossing and a Raytheon site station than depressing them. Elevating the tracks at this location would have a negative visual impact on the Wayland historic district, however.

Routes 27 and 126 merge just south of their crossings of the railroad and cross Route 20 at a signalized intersection 600 feet further south. At times of heavy

traffic, queues of cars extending over the railroad crossings would be a safety issue.

In addition to the public crossings, there are at least 5 authorized private crossings between Stony Brook Junction and I-495. Some abutting property owners with land on both sides of the right-of-way have constructed unapproved crossings since service on the line ended, but the MBTA would have the right to close these if the line reopened.¹⁴

In addition to the grade crossings on the Central Mass. route itself, Central Mass. trains entering the Fitchburg Line at a junction between Kendal Green and Brandeis/Roberts would pass through 8 grade crossings on that line. This would include 4 crossings in Waltham, 1 each in Belmont and Cambridge, and 2 in Somerville. The most heavily traveled of these is the Moody Street crossing in Waltham, which is located between the existing inbound and outbound Waltham Station platforms. This crossing is viewed by the city of Waltham as a serious impediment to traffic flow even with existing rail service levels. Additional traffic studies would be needed to determine the impact of adding Central Mass. service.

Impacts on Abutters

Between Stony Brook Junction and I-495 there are about 150 houses within 200 feet of the Central Mass. right-of-way. Of these, about 50 are east of South Sudbury, 40 between South Sudbury and Kane Drive in Hudson, and 60 between Kane Drive and I-495. Therefore, a South Sudbury extension would impact a much smaller number of abutters than extensions to Hudson or I-495.

The Central Mass. line has carried no trains east of Hudson since 1980 and none west of Hudson since 1975. Many of the houses close to the right-of-way were built before previous rail service ended, but, after 1971, traffic consisted of at most one freight train per day in each direction. Because of normal occupancy turnover, it is likely that a substantial percentage of the residents of these houses moved in after 1980, and an even higher percentage after 1971.

In the past few years, several new residential subdivisions have been developed close to the right-of-way, and land has been cleared for additional houses. The largest new subdivisions are in the eastern half of Wayland and the western half of Sudbury. (Those in the latter location would be beyond the end of a route terminating at South Sudbury.) Restored passenger service, even at the lowest frequency considered in this study (eight round-trips per day) would be far in excess of what most present occupants of houses near the Central Mass. right-of-way have ever experienced there. Negative impacts for these residents would

¹⁴Massachusetts law prohibits the establishment by adverse possession of new crossings over railroad rights-of-way.

consist of noise and vibration from trains as they pass and the sounding of train horns at the grade crossings.

Most of the houses close to the right-of-way would be too far from the most likely station sites to be impacted by station traffic. The volume of traffic passing houses along Route 20 east of South Sudbury would decrease slightly because of diversions to the rail line.

9. SUMMARY AND CONCLUSIONS

A Central Mass. commuter rail extension either to Route I-495 in Berlin, to Main Street at Kane Industrial Drive in Hudson, or to South Sudbury would be feasible from an operations standpoint but would produce very limited benefits for the costs involved. At current travel levels, about 1,300 riders in each direction would ride trains on an I-495 extension on weekdays. Of these riders, about 580 (45%) would be former auto drivers or passengers. The remainder would be diverted from other transit services. The maximum highway traffic impact of the extension would be felt on Route 20 in Weston, where there would be a reduction of about 17% in the number of peak-direction vehicles during commuting hours. Future growth in travel would increase ridership on the extension by only about 5% over the 1996 level by the year 2020.

Line-haul rail travel times to Boston would, at best, be a few minutes shorter than travel times for single-occupant auto trips from stations in Hudson, Sudbury and Wayland, but several minutes longer than auto times from I-495. Rail times would be significantly shorter than current scheduled express bus times from the corridor, but few corridor residents now use the buses.

Incremental fare revenue from an I-495 extension would cover only about 12% of incremental operating cost, which would be far below acceptable levels. An extension only to Hudson would have a revenue-to-cost ratio of 14%. An extension only to South Sudbury with minimum acceptable service would have a revenue-to-cost ratio of 27%, which would still be relatively low.

Capital costs for necessary right-of-way improvements, station platforms and parking, and additional rolling stock would total \$103.2 million for an extension to I-495, \$72.2 million for an extension to Kane Drive in Hudson, or \$46.8 million for an extension to South Sudbury with reduced service frequency. The respective capital costs per new transit user on the extension itself would be \$177,931, \$131,318, or \$111,303. Any of the three alternatives would be among the most costly per new transit rider of all MBTA commuter rail extensions analyzed recently.

An extensions to any of the three terminals analyzed would improve air quality slightly, but the capital cost per weekday kg of VOC elimination would range from \$3.3 million with a South Sudbury terminal to \$7.0 million with an I-495 terminal. In this measure, a Central Mass. extension would be more costly than most of the commuter rail improvement or extension projects examined in the MBTA's 1994 Program for Mass Transportation.

These findings are summarized in Table 9-1.

Table 9-1
Summary of Performance Measures for
Central Mass. Extension to I-495, Hudson, or South Sudbury

<u>Item</u>	<u>To</u> <u>I-495/Berlin</u>	<u>To Hudson</u>	<u>To South</u> <u>Sudbury</u>
Weekday Inbound riders	1,295	1,245	950
New Transit Riders Included Above	580	550	420
Annual Operating Cost	\$11,995,000	\$9,830,000	\$3,315,000
Incremental Fare Revenue	\$1,445,000	\$1,375,000	\$910,000
Incremental Revenue/Operating Cost	0.121	0.140	0.274
Capital Cost	\$103,200,000	\$72,225,000	\$46,785,000
Capital Cost/New Transit Rider	\$177,931	\$131,318	\$111,393
Capital Cost/Kg of Weekday VOC Reduction	\$6,973,000	\$4,630,000	\$3,342,000

Note: South Sudbury figures are based on reduced weekday service, with no weekend service.

APPENDIX A - FURTHER DETAILS ON EXISTING PUBLIC TRANSPORTATION SERVICE IN STUDY AREA

Chapter 2 of this report provides general descriptions of the existing bus routes serving the Central Mass. extension corridor directly or indirectly. The first section of this appendix describes the present private-carrier bus routes in greater detail. The second section contains transit ridership information for the Central Mass. corridor.

Descriptions of Existing Bus Routes

Post Road Line

The outer terminal of this line is at the intersection of Routes 135 and 20 in Northborough. Buses run on Route 20 through Northborough, Marlborough, Sudbury, Wayland, and Weston, then follow Route 128 and the Mass. Turnpike into Boston. There is one inbound trip in the A.M. peak and one outbound trip in the P.M. peak, but there are no off-peak trips. This level of service has been in effect since 1984.

This route includes one stop each in Northborough, Wayland, and Weston, and two each in Marlborough and Sudbury. Marlborough and Northborough are not directly on the Central Mass. route, but the other three towns are. The stops in Sudbury, Wayland and Weston are all within one half-mile of the Central Mass. right-of-way.

At the inner end, buses leave the Mass. Turnpike at the Copley exit and make stops at Copley Square, Park Square, South Station and Government Center. Scheduled running times to Copley range from 30 minutes at Weston Center to 50 minutes at Northborough. Based on the CTPS travel time runs discussed in chapter 2, these times are 6-8 minutes longer than required under average traffic conditions. The additional time from Copley Square is three minutes to Park Square, 10 minutes to South Station, and 15 minutes to Government Center. (At South Station buses stop on the street rather than entering the intercity bus terminal.)

Gulbankian Bus Lines Hudson-Boston Route

This route begins in downtown Hudson at the intersection of state Routes 62 and 85 and follows a combination of Route 85 and parallel local roads through Marlborough and Southborough to Route 9. It then follows Route 9 to Mass. Turnpike Exit 12 in Framingham, and the Turnpike to downtown Boston. There is one stop in Hudson, four in Marlborough, two in Southborough, and one in Framingham. The Hudson stop is less than one quarter mile from both of the former Central Mass. downtown Hudson Station sites, but would be 3.3 miles from a station at Kane Industrial Drive.

The inbound A.M. peak trip leaves the Mass. Turnpike at the Copley exit and make stops at Copley Square, the State Transportation Building, the State House, Park Street Station, and South Station. The outbound P.M. peak trip serves the same stops, except for Park Street Station, in the reverse order. Off-peak trips serve various combinations of the Boston stops. Inbound peak scheduled running times to Copley range from 33 minutes at Framingham to one hour and 15 minutes at Hudson. (The running time from Framingham to Copley is consistent with CTPS timing run data for the Turnpike.) Additional running times to stops after Copley range from five to 20 minutes.

Peter Pan Bus Lines Shoppers World Express and Route 9 Local Service

Buses on the Shoppers World express route use the Mass. Turnpike between Exit 13 in Framingham and Boston. Trips originating at the Edgewater apartment complex follow Route 9 from there to Shoppers World. Various combinations of Boston stops are made on different trips, including Copley Square, Park Square, Post Office Square, and the South Station bus terminal. The peak scheduled running time between Shoppers World and Copley Square is 25 minutes inbound and 30 outbound, with five to 35 minutes longer to other Boston stops, and 20 minutes additional from Edgewater.

On the Route 9 local service, the scheduled running time is 45 minutes from Shoppers World to Copley Square, 50 minutes to Park Square, and one hour to South Station. Times are five minutes less from Route 27 in Natick and 20 minutes less from Wellesley Hills.

Census and Survey Transit-Ridership Totals from Central Mass. Corridor

U.S. Census Journey-To-Work tabulations include breakdowns of work trips to Boston Proper, other Boston, and Cambridge from each city and town of residence, by mode of travel. Within modes, these figures do not indicate which route is used if there is more than one possibility, and commuters who alternate among two or more modes are counted under only one of them. Nevertheless, these data provide a general picture of the extent to which residents of individual towns use mass transit to travel to work. Information on origins, destinations and trip purposes of passengers using MBTA commuter rail, express bus and rapid transit lines is available from surveys conducted between 1993 and 1995. This provide a cross-check on the Census data. Results for towns in the Central Mass. service area are summarized below.

Weston

Weston is the nearest community to Boston and Cambridge in the Central Mass. service corridor. Although it does not have the largest population, it originates the largest numbers of Boston and Cambridge work trips of any municipality in the corridor. There are also more transit stops in or near Weston than in any

other Central Mass. city or town. Consequently, Weston has the largest number of transit users in the corridor.

According to the 1990 Census figures, Weston generated 1,508 work trips to all of Boston or Cambridge, of which 303 (20%) were made by mass transit. Of these, commuter rail captured the largest share, with 166 (11%), followed by express bus with 89 (6%), and trolley or subway with 48 (3%). Comparisons with MBTA survey data suggest that the transit totals for all sub-modes are overstated by 30% to 45% in the Census figures, however.

Commuter rail boardings from Weston are divided among several stations. Kendal Green on the Fitchburg Line and Wellesley Farms on the Framingham Line each account for about 32%. Auburndale Station is used for 18% of commuter rail trips from Weston, with the remaining 18% split between Hastings, Silver Hill, Brandeis/Roberts, Wellesley Hills, and Wellesley. Most of the trolley or subway boardings from Weston occur at Riverside, with fewer than 10 to Alewife Station on the Red Line. The most common express bus boarding points are Riverside on Route 500 and West Newton on Route 505. (Prior to September 1996 these were routes 300 and 305.) Only about five Weston residents use the Post Road express bus, even though it stops directly in the town.

Wayland

Wayland is the second-closest community to Boston and Cambridge in the Central Mass. service corridor, and the closest that is not directly on an existing commuter rail line. Wayland is also second among corridor towns in total Boston and Cambridge work trips. According to the 1990 Census figures, Wayland generated 1,332 work trips to all of Boston or Cambridge, of which 202 (15%) were made by mass transit. Of these, commuter rail captured the largest share, with 98 (7%), followed by express bus with 86 (6%), and trolley or subway with 18 (1%).

The commuter rail and trolley/subway Census numbers are consistent with MBTA surveys. Commuter rail boardings from Wayland are divided among several stations. Auburndale and Natick on the Framingham Line and Kendal Green on the Fitchburg Line each serve about 25%. Smaller numbers go to Wellesley Farms, Wellesley, and Lincoln. According to survey results, about one third of trolley/subway boardings from Wayland occur at Riverside, with the balance at Alewife.

The Census totals for express bus use by Wayland residents appear to be too high. Route 500 boardings at Riverside by Wayland residents would account for about half of the Census bus totals. Only about five Wayland residents use the Post Road express bus, even though it stops directly in the town. Old survey results show no use of Shoppers World express buses by Wayland residents.

Sudbury

Sudbury is the third-closest community to Boston and Cambridge in the Central Mass. service corridor, and is also third among corridor towns in total Boston and Cambridge work trips. According to the 1990 Census figures, Sudbury generated 1,047 work trips to all of Boston or Cambridge, of which 109 (10%) were made by mass transit. Of these, commuter rail captured the largest share, with 51 (5%), followed by trolley/subway with 36 (3%), and express bus with 22 (2%). Comparisons with survey figures suggest that the Census totals may understate commuter rail ridership from Sudbury by about 50%, and express bus ridership by about 66%, but that trolley/subway ridership may be overstated by 50%.

About 75% of the commuter rail boardings by Sudbury residents occur at Lincoln Station. The remainder are scattered among South Acton, West Concord and Kendal Green on the Fitchburg Line and West Natick, Wellesley Farms, and Auburndale on the Framingham Line. About one quarter of trolley/subway boardings from Sudbury occur at Riverside, with the balance at Alewife. The main MBTA express bus boarding point for Sudbury trips is Riverside. Only about ten Sudbury residents use the Post Road express bus, even though it stops directly in the town. The Shoppers World express buses are also accessible from Sudbury, but are used by only an estimated 5-10 Sudbury residents each day.

On-Line Towns West of Sudbury

Work-trip orientation to Boston and Cambridge drops substantially west of Sudbury in the Central Mass. corridor. The 1990 Census figures show totals of 393 Boston or Cambridge work trips from Hudson, 114 from Bolton, and 46 from Berlin. The only mass transit mode serving any of these trips, according to the Census figures was commuter rail, but these results are unreliable because of the small sample size. Census and survey results both show 25 to 30 commuter rail trips from Hudson. The most commonly reported boarding point for these was South Acton, followed by Lincoln. The Census reported no bus trips from Hudson, but boarding counts for the bus route that originates there show about five Boston riders per day.

Census figures for Bolton show 39 commuter rail trips to Boston or Cambridge, but the survey found only half this number. Most of the boardings took place at South Acton. From Berlin, the Census showed three commuter rail trips, but the survey had no responses.

Adjoining Towns

As discussed in chapter 2, several of the towns adjoining those directly on the Central Mass. route currently have commuter rail service, or adjoin other towns that do. Most residents of these towns would have to travel further to reach

stations on the Central Mass. than to reach existing stations, so the Central Mass. would have little potential for attracting riders from them. Therefore, the discussion in this section is limited to municipalities that do not currently have commuter rail service closer than would be provided by the Central Mass. This leaves Clinton and Boylston to the west, Marlborough to the south, and part of Stow to the north.

From Clinton, the Census showed 130 Boston or Cambridge work trips. No transit trips were shown, but the survey results show 21 commuter rail and four Red Line trips, equivalent to 16% and 3% shares.

From Boylston, the Census showed only 15 Boston or Cambridge work trips, with none by mass transit. The 1993 survey also had no commuter rail work trips from Boylston, but a survey of passengers boarding at Worcester Station after service was extended there in 1994 showed one origin from Boylston. A 1995 survey of bus Route 300 also had one response from a Boylston resident boarding at Riverside. No trolley or subway trips from Boylston were found in surveys.

The city of Marlborough has a larger population than any town directly on the Central Mass. line, but also has relatively low orientation to Boston or Cambridge. As a result, it generates more work trips to these cities than Hudson, Berlin and Bolton combined, but fewer than Weston, Wayland, or Sudbury individually. The 1993 Census results show 893 Boston or Cambridge work trips from Marlborough, with 48 by commuter rail, 25 by bus, and none by rapid transit. Commuter rail and bus survey results are consistent with this, but also show 13 Green Line boardings from Marlborough at Riverside and four Red Line boardings at Alewife.

From Stow, the Census showed 216 Boston or Cambridge work trips, with 63 (29%) by commuter rail and seven (3%) by trolley or subway. The 1993 survey found only 46 Boston or Cambridge work trips by commuter rail. (About half of these originate in sections of the town that would have better access to a Central Mass. station in Hudson than to existing commuter rail stations.) Survey results from 1994 found 17 work trips from Stow to all destinations using the Red Line at Alewife, but none using the Green Line or MBTA express buses.

APPENDIX B - FURTHER DETAILS ON FORMER CENTRAL MASS. ALIGNMENT BETWEEN WALTHAM AND BOSTON

In the past, Central Mass. trains used several different routings between Waltham and Boston. As a result, documents from different eras contain conflicting information as to where these trains ran. This appendix is intended to clarify past Central Mass. routings, and to explain why many of them can no longer be considered as alternatives for future service.

As originally planned, the Central Mass. rail line was to have branched from what was then the Fitchburg Railroad at the location on the Waltham/Weston border referred to in this study as Stony Brook Junction. As actually opened in 1881, however, the Central Mass. extended to North Cambridge, to connect directly with the Boston & Lowell Railroad system, with which it had become affiliated.

At the Stony Brook Junction site, the Central Mass. crossed the Fitchburg Line on a bridge, and there was no track connection between the two lines. From there, the Central Mass. continued on a separate right-of-way at distances of up to a mile north of the Fitchburg Line, finally converging with the latter just east of Linden Street in Waltham. (The alignment through Waltham is shown on the map on page 13.) The Central Mass. then had a separate track immediately to the north of the Fitchburg Line tracks to the border of Belmont and Cambridge. Diverging to the north again, the Central Mass. continued to a connection with the Boston & Lowell Railroad's Lexington Branch at North Cambridge Junction (between the present locations of Alewife Brook Parkway and Massachusetts Avenue). Central Mass. trains used the Lexington Branch from there to the B&L Main Line at Somerville Junction, and the Main Line for the remaining distance to the B&L terminal near the present North Station. (Part of the old B&L Main Line used by Central Mass. trains now serves MBTA Lowell Line trains, but much of it is now a freight-only line to East Cambridge.)

The Central Mass., the Fitchburg, and the Boston & Lowell Railroad had all become part of the Boston & Maine Railroad system by 1900. As early as 1914, the B&M drew up plans for a connection between the Central Mass. and the Fitchburg near their crossing in Weston, but it was never built.

Central Mass. trains continued running on their original route between Waltham and Boston until 1928, when a major modernization of the Boston & Maine's terminal facilities in Boston began. As part of this project, the Central Mass. and Lexington Branch segments between Hill Crossing Station in Belmont (at Brighton Street) and Somerville Junction were converted to a route for freight trains only, re-named the Freight Cut-off. Central Mass. passenger trains were re-routed over a new alignment parallel with the Fitchburg Line between Hill Crossing and a junction called Fens, near the crossing of Alewife Brook Parkway

over the Fitchburg. From there to North Station, Central Mass. trains used the Fitchburg tracks.

The next major change in routing of Central Mass. trains east of Waltham took place in 1952, when the Fitchburg Line tracks were depressed at Waverley Square in Belmont to eliminate two grade crossings. Because of the limited traffic on the parallel Central Mass. line, it was not depressed. Instead, Central Mass. trains were shifted onto the Fitchburg Line between Fens and Clematis Brook Station in Waltham (at Beaver Street). The Central Mass. tracks from Hill Crossing to Clematis Brook were then removed. Central Mass. passenger trains continued using the Fitchburg Line east of Clematis Brook until the end of service in 1971.

The Freight Cut-off remained available as an emergency detour route into Boston for passenger trains until 1979. At that time, construction of the Red Line Alewife extension subway in the right-of-way forced abandonment of most of the line. A pedestrian and bicycle path was subsequently built on this segment.

Because of the changes in the former Central Mass. right-of-way described above, a connection with the Fitchburg Line further east than Clematis Brook would no longer be feasible. More detailed analysis would be needed to determine the maximum combined level of service from the two routes that could be accommodated on the shared portions of the Fitchburg Line.

APPENDIX C - ANALYSIS OF EXTENSION BEYOND I-495 AND EXTENSIONS BRANCHING FROM CENTRAL MASS.

Extension West of I-495

The segment of the Central Mass. from Berlin Station to East Switch in Clinton was abandoned in 1959. Passenger service had been cut back from Clinton to Hudson the previous year. This segment of the Central Mass. crossed the Nashua River on a long high trestle just below the Wachusett Dam. The trestle has now been dismantled. Replacing it would not only be costly but would be objectionable because of its location in a park. An alternate route to Clinton involving much less construction would consist of building a connection between the Central Mass. one mile west of Berlin Station and the existing Conrail Fitchburg Secondary Track¹⁵. This line runs through downtown Clinton and passes the same station site formerly used by Central Mass. trains there. A connection between the two lines in Berlin existed at one time, but was never used for through passenger service. A trestle approximately 1,000 feet long would be required to carry the connecting track over the North Brook valley at West Berlin.

In the past, trains that continued beyond Berlin to Clinton made no other stops on the Central Mass. itself. (The last 0.9 miles into Clinton station from East Switch was on the Boston & Maine's Worcester Route Main Line.) Clinton Station was in the center of the town, near the intersection of Main and Water streets. It was a two-level union station, with the Boston and Maine Railroad tracks on the lower level and the New Haven Railroad (now Conrail) tracks on the upper level. The station building is still standing, but has been converted to non-rail-related uses. There is very limited room for parking near this site. This station was 37 miles from Boston via the routing used until 1958. A new routing via the Conrail line between West Berlin and Clinton would be 0.3 miles shorter.

The fastest possible running time between an I-495/Berlin station and Clinton via the route described above would be about 10 minutes. With the minimum stop configuration between I-495 and Boston, the total running time from Clinton to North Station would be about 64 minutes. There is currently no bus service from Clinton to Boston to compare with this. Driving time from downtown Clinton to downtown Boston via the fastest route would be about one hour at peak times.

According to the 1990 Census Journey-to-Work tabulations, only 130 residents of Clinton were employed in Boston or Cambridge. Even with direct service to downtown Clinton, a Central Mass. extension could not be expected to capture

¹⁵Conrail has recently agreed to sell the Fitchburg Secondary to RailTex, a San Antonio-based operator of regional rail systems, subject to regulatory approval. This should not affect the practicality of a Central Mass. extension involving the line, however.

all of these trips. The travel time saving compared to driving to an I-495 terminal would be under five minutes from all points in Clinton.

A downtown Clinton station would be the nearest commuter rail facility for residents of portions of the towns of Lancaster, Sterling and Boylston, but these towns had only 48, 24, and 15 Boston or Cambridge workers, respectively, in 1990. Stations on the Fitchburg or Framingham/Worcester lines would continue to be more convenient for some of them. Because of the limited ridership potential and travel time savings, an extension west of I-495 is not examined further in this study.

Extension Using Marlborough Branch Right-of-Way

West of Sudbury, the largest individual source of Boston and Cambridge work trips in the Central Mass. service area is Marlborough. The Central Mass. itself does not pass through Marlborough, but at Gleason Junction in Hudson it intersects the abandoned right-of-way of the former Fitchburg Railroad Marlborough Branch. Passenger service from Boston to Marlborough via the Central Mass. and the Marlborough Branch was operated from 1902 to 1939. Also, from 1958, after passenger service was cut back from Clinton to Hudson, until 1965, when it was further cut back to South Sudbury, Central Mass. trains used a terminal in Hudson on the Marlborough Branch rather than the station on the Central Mass. line. Therefore, use of part of the Marlborough Branch as the western end of a Central Mass. extension is examined here.

The Marlborough Branch right-of-way is mostly intact and owned by the MBTA. A new road has been built along a short section of the alignment in downtown Hudson, but restoration of a track there appears to be feasible if this should prove to be desirable in other respects.

The Marlborough Branch alignment includes several sharp curves. Historically, these, along with grade crossings, limited the maximum speed on the line to only 35 m.p.h. This would result in a running time of about nine minutes from Marlborough to Gleason Junction or 18 minutes from Marlborough to South Sudbury with one intermediate stop at Kane Drive in Hudson. With the stops between South Sudbury and Boston only at Wayland, Waltham, and Porter Square, the total time from Marlborough to North Station would be 55 minutes.

For comparison, current scheduled bus times from Marlborough to Copley Square range from 55 to 70 minutes depending on boarding location. The peak driving time from downtown Marlborough to Copley via the fastest route is about 45 minutes. The train running time from Marlborough Station to South Sudbury Station would be about five minutes longer than the driving time between these points, so a direct extension of rail service to Marlborough would not reduce overall travel time compared to Central Mass. service on the main line only. (Because of road layout, most Marlborough residents would have better

access to South Sudbury than to Kane Drive.) The former Marlborough Station site is in a congested downtown area with little or no room for parking. The topography along the branch would limit the possibilities for alternate station locations. For these reasons, a Marlborough extension is not considered further in this study.

Extension Using Lowell Secondary Track

The only rail right-of-way other than the Marlborough Branch intersecting the Central Mass. between Waltham and Berlin is the former New Haven Railroad Lowell Secondary Track¹⁶. This line formerly ran from Framingham Center to Lowell, crossing the Central Mass. at grade at South Sudbury. The segment from Framingham to South Sudbury is still operated by Conrail for freight service. The rest of the line is abandoned and partly dismantled. The right-of-way from South Sudbury to the outskirts of Lowell is owned by EOTC.

Passenger service on the Lowell Secondary ended in 1933. There was never a track connection permitting operation of through trains between the Central Mass. and the Lowell Secondary at South Sudbury, although it was possible for Boston commuters to transfer there. The orientation of the Lowell Secondary, at right angles to the Central Mass., would not be conducive to attracting riders who would not use other rail service. Seven miles to the north of the Central Mass., the Fitchburg Line would be crossed at West Concord Station, and seven miles to the south the Framingham/Worcester Line would be crossed at Framingham Station. For these reasons, an extension of the Central Mass. involving use of the Lowell Secondary right-of-way is not examined further in this study.

¹⁶A rail line from Hudson to Lancaster built in 1872 by the Lancaster Railroad was never operated, and was dismantled in 1889. Although much of the right-of-way remains intact, there are too many missing sections for this to be considered as a future rail route.

APPENDIX D - ANALYSIS OF ALTERNATE STATION LOCATIONS

Importance of Highway Access in Station Site Selection

In the 1993 commuter rail survey, among passengers who reported walking as their mode of access to the outer boarding station, 96 percent reported access times of 20 minutes or less. At typical walking speeds, this would mean that most walk-ins had access distances of under one mile. As will be seen from the discussion below, the number of potential users of a Central Mass. commuter rail extension who would live within one mile of most possible station sites would be small. Trip origins would also be too widely scattered to allow cost-effective feeder services. Therefore, in planning stations for the extension, highway access and parking availability would be of critical importance.

As discussed in chapter 4, home-to-work trips ending in either Boston or Cambridge account for 79% of the inbound weekday ridership on the existing commuter rail lines terminating at North Station. Work trips to the Boston Central Business District alone account for 65% of the ridership. It is reasonable to assume that Boston and Cambridge work trips would also be the primary market for a Central Mass. commuter rail extension. Journey-to-Work figures from the 1990 Census show that under 7% of the residents of any town in the probable attraction area of a Central Mass. extension work in Boston Proper, and that under 15% are employed in all of Boston and Cambridge combined. (Only Weston and Wayland have over 8% of their residents employed in Boston or Cambridge.)

A circle with a radius of one mile centered on a rail station, representing the walk-in attraction area, would have a total area of about three square miles. If population density were uniform, such a circle drawn in Weston or Wayland would have enclosed an average of about 270 Boston or Cambridge workers in 1990. Because of wetlands along much of the right-of-way, however, population density nearest the rail line in both towns is below these averages. Drawn in any on-line town west of Wayland a one-mile radius circle would enclose fewer than 135 Boston or Cambridge workers. Not all of these workers would have chosen to use commuter rail service if it were available. These calculations indicate very limited walk-in potential at any individual station site along the Central Mass. (In 1994 A.M. peak counts at stations in Weston, Kendal Green had fewer than 25 walk-ins. Hastings had 8, and Silver Hill had 6.)

Identification of specific station sites on a Central Mass. commuter rail extension is beyond the scope of this study. For purposes of analyzing ridership, travel times, and traffic impacts of the extension, however, it is necessary to make some assumptions about approximate station locations. Past station sites are considered first, but it is not assumed that future station locations would correspond with any or all of these.

General Characteristics of Past Central Mass. Stations

Except for a section of paved platform at South Sudbury, none of the past station sites on the Central Mass. have any remains of platforms, lighting, or parking facilities that would be suitable for future rail passenger service, so construction costs would be similar for these sites or entirely new ones. Most of the past stations were located when the line was constructed in the 1880s. Access then would have consisted mainly of walk-ins with some drop-offs by horse and carriage, so there was no reason to provide for all-day vehicle parking. Traffic levels on the line never grew sufficiently to call for major station modernization. Several of the original station buildings were still in use when passenger service ended in 1971. A few had been replaced because the older ones had burned or were too large to maintain economically. Off-street parking at stations on the line consisted at best of a few unpaved spaces.

Locations of Past Central Mass. Stations

In the final years of operation of Central Mass. passenger trains, the only station on the Fitchburg Main Line served by these trains was Porter Square in Cambridge. Because of the importance of Porter as a destination, future Central Mass. trains would also stop there. The only currently active stations between Porter and the former junction at Clematis Brook are Waverley and Belmont. Service to these by Central Mass. trains would be optional. If the Central Mass. diverged at the Stony Brook Junction site, trains could also stop at Waltham and Brandeis/Roberts. At present, all Fitchburg Route trains are scheduled to stop at Waltham, and Central Mass. trains probably would also if routed this way. Past Central Mass. trains stopped at two stations in Waltham (Waltham North and Waltham Highlands). If future service were run on that alignment it would probably include one station in Waltham.

All Fitchburg Route trains except for one inbound and two outbound stop at Brandeis/Roberts. In addition to serving inbound work trips to Cambridge and Boston, this is the destination station for trips to Brandeis University and a nearby office park. It is likely that at least some Central Mass. trains would also stop there if routed that way.

On the remainder of the Central Mass. between Waltham and Berlin, there were historically two stations each in Weston and Wayland, three each in Sudbury and Hudson, and one each in Bolton and Berlin. Individual station locations are described in greater detail below, with mileages from North Station in parentheses. These distances are via the original alignment through Waltham. Distances via a new Fitchburg Line connection would be 0.8 mile longer.

Weston

In Weston, the stations were Weston, at Church Street (12.9 mi.) and Cherry Brook, at Concord Street (13.7 mi.). Both were still being served when passenger service on the Central Mass. ended in 1971. Neither was heavily patronized, but Weston Station served the greater number of riders.

The original Weston Station building still exists on the site, but is vacant. It could potentially serve as a waiting facility for a future walk-in station, but there is little room for parking there. Kendal Green Station on the Fitchburg Line is also on Church Street, less than one mile from Weston Station.

Cherry Brook Station had a small wooden shelter, which has deteriorated beyond repair. Silver Hill Station on the Fitchburg Line is 1.9 miles north of Cherry Brook. It is closer to more homes than Cherry Brook Station would be, but is one of the least-patronized stations in the MBTA commuter rail system. (Only two inbound trains a day stop at Silver Hill, both in the A.M. peak. A November 1994 CTPS count found four boardings on each train at Silver Hill.)

Wayland

In Wayland, the stations were Tower Hill, at Plain Road (15.3 mi.) and Wayland, at Sudbury Road (16.5 miles). Both were still being served when passenger service on the Central Mass. ended, with Wayland Station being used by the greater number of riders.

Tower Hill had a small wooden shelter, which has now deteriorated beyond repair. This site is in a residential area with no room for parking. The original Wayland Station building has been restored by the town, and is used as a gift shop. Its site at the convergence of state Routes 27 and 126 and U.S. Route 20 would be the most centrally located of any in town, but a modern station there would be incompatible with the historic station. Some possible alternate station sites for Wayland are discussed in chapter 3.

Sudbury

In Sudbury, the stations were East Sudbury, at Landham Road (18.6 miles), South Sudbury, at Union Avenue (19.7 miles), and Wayside Inn, at Dutton Road (21.6 miles). East Sudbury and South Sudbury were still being served when passenger service on the Central Mass. ended, with South Sudbury being used by the greater number of riders. The Wayside Inn stop had been discontinued in the 1930s.

There does not appear to be sufficient vacant land around the East Sudbury Station site to provide adequate parking. South Sudbury would be a likely station site on a future Central Mass. extension, and is discussed in greater detail

in chapter 3. The Wayside Inn Station site is in a residential area, with poor access from Route 20 and no room for parking. No station buildings remain at either East Sudbury or Wayside Inn now. A small wooden enclosed waiting room built in the 1950s at South Sudbury still exists, but is currently vacant.

Hudson

In Hudson, the stations were Ordway, at Parmenter Street (23.9 miles), Gleasondale, at Chestnut Street (25.4 miles), and Hudson, between Felton and Pope Streets 27.7 miles). Ordway and Gleasondale were used until the outer limit of passenger service was cut back to South Sudbury in 1965. Hudson Station was served until October 1958, when remaining Central Mass. trains were re-routed onto the Marlborough Branch at Gleason Junction. The Hudson Station on that line was at Broad Street, south of Main Street. This station was about the same distance from Boston as the Felton Street station, and was used until 1965.

There is some vacant, industrially zoned land at Ordway Station, but the site is not close to any state highways. No station building remains there now. The station at Felton Street has been remodeled into professional offices. The limited parking at this site is used in conjunction with these offices. (The shift in passenger train routing in Hudson was apparently made more to facilitate the re-use of the station than for transportation reasons.) The site is, however, near the intersection of Routes 85 and 62, which would make it a convenient drop-off location. A possible new station site in Hudson between the former Ordway and Gleasondale sites is discussed in chapter 3.

Bolton

The Central Mass. right-of-way passes through the southern edge of the town of Bolton for a distance of less than 1,000 feet. The station for that town was South Bolton, near the crossing of Central Street on the Hudson-Bolton town line. This was 0.3 miles east of the present location of Route I-495. This station was discontinued in the early 1930s. No building remains there now. The site is near the interchange of Routes 62 and I-495, but has no room for parking. A new site closer to I-495 would be preferable. Such a site is discussed in chapter 3.

Berlin

Berlin Station was at Highland Street in Berlin, 1.4 miles west of I-495. It was served until 1958, when the outer end of Central Mass. passenger service was cut back to Hudson. The site is in a residential area, with inadequate room to provide for parking. No station building remains there now.

Proximity of Potential Station Sites to Major Highways

As discussed in chapter 2, most of the towns along the Central Mass. right-of-way have no limited-access highways within their borders. In Weston, a new commuter rail station is planned on the Framingham Line directly beside the interchange of the Mass. Turnpike and Route 128. On the Central Mass., the nearest point to this interchange by road would be three miles away. Therefore, a Weston station on the Central Mass. could not be expected to attract any traffic via the Mass. Pike that would not otherwise go to the new Framingham Line station.

Between the Waltham-Weston border and South Sudbury, U.S. Route 20 runs parallel with the Central Mass. at a distance of half a mile or less. At South Sudbury they begin diverging, but are only two miles apart at the western border of Sudbury. Because of this proximity, and the locations of other streets in the towns, much of the traffic approaching the railroad would do so at least in part via Route 20. The potential new station sites discussed in chapter 3 in Wayland and Sudbury would have slightly better access from Route 20 than the station locations that were used in the past, but the differences would not be sufficiently great to make conclusions of the study dependent on obtaining these specific sites.

In Berlin, the Central Mass. right-of-way crosses Route I-495 at its interchange with state Route 62. The orientation of I-495 at this point is generally north and south. The next interchange to the north of Route 62 is at Route 117 in Bolton. This would provide quick access to the Central Mass. from the Center of Bolton, but the 1990 Census showed only 114 residents of that town working in Boston or Cambridge.

The next interchange to the north of Bolton is at Route 111 in Boxborough, 7.3 miles from Route 62. The driving distance to the Littleton/495 Station on the Fitchburg Line is under 4.5 miles from any point in Boxborough, however. Therefore, Central Mass. service could not be expected to attract any riders via I-495 from towns further north than Bolton.

To the south of Route 62, the next two interchanges on I-495 are both in Marlborough, at Route I-290 and at U.S. Route 20. Marlborough residents using the Central Mass. could use either the I-495/Berlin station or a South Sudbury station. About two thirds of the land area of Marlborough, and an even higher proportion of the population, is situated to the east of I-495. Therefore, the majority of Marlborough residents would have to start by driving in the opposite direction from Boston to reach I-495. From the center of Marlborough, driving time to the I-495/Berlin station would be about two minutes faster than the driving time to South Sudbury, but the time on-board the train would be 17 minutes less from South Sudbury. The time advantage of South Sudbury would increase from points east of Marlborough Center. It would decrease from points

further west, but there would be few, if any, points in Marlborough from which overall travel time would be faster via I-495/Berlin. South Sudbury would have the added attraction of being in a lower fare zone.

The next interchange south of Marlborough on I-495 is at Route 9 in Westborough, but from there, planned stations on the Framingham/Worcester commuter rail line would be much closer. On I-290 west of Marlborough there are two interchanges in Northborough, but most of the population of this town would have faster access to stations on the Framingham/Worcester Line than to the Central Mass. Beyond Northborough, there are two interchanges in Shrewsbury, but that town is also closer to the Framingham/Worcester Line. In conclusion, a station at I-495 would be of very limited advantage in attracting riders to the Central Mass. line.

As discussed in Chapter 3, a station in Hudson near Kane Industrial Drive would be on the primary traffic route from Hudson to Sudbury and towns to the east, although it is not a numbered highway. State Route 62 joins Main Street 1.5 miles west of Kane Drive and continues west through downtown Hudson, past the Berlin/I-495 station site, and into Clinton and beyond. The Kane Drive station would be 4.3 miles from the center of Stow via a combination of Route 62 and local roads. It would be 6.8 miles from the center of Bolton via a combination of routes 85 and 62 and Main Street. Because of road layout, a Kane Drive station would be less convenient than South Sudbury for most trips originating in communities south of Hudson. None of the towns that would be served by the station are major sources of trips to Boston or Cambridge.

APPENDIX E - RIDERSHIP ESTIMATION METHODOLOGY

Chapter 4 of this report describes the travel markets expected to be served by a Central Mass. extension, and summarizes the predicted ridership from these markets. This appendix provides further details in the methods that were used in estimating ridership.

Extension Share of Boston Proper Work-Trip Market at 1990 Travel Levels

The share of the Boston Proper work-trip market captured by the existing commuter rail lines varies widely among the cities and towns served. These differences can be attributed to many underlying causes, but are influenced strongly by the range of options available to residents of these communities. In general, among cities and towns with direct commuter rail service, the highest rail market shares are found where average rail travel speeds are highest, highway access to Boston is poorest, no other direct transit alternatives are available, and rail access is unconstrained by parking capacity. Rail typically also attracts higher market shares as travel distance from Boston increases.

A Central Mass. Line would terminate at North Station, so passengers alighting there would have the same options for continuing to their final destinations as passengers on other North Side Lines. Based on Census and survey data for communities on existing North Side lines, a Central Mass. extension with unconstrained parking could be expected to capture about 40% of the work trips to Boston Proper from its on-line towns. In general, commuter rail captures smaller shares of trips from cities and towns without stations than from those with direct service, but there are exceptions. These are most likely to occur in cases where direct transportation service to Boston by modes other than rail is inconvenient, but there is good access to a rail station in a nearby town. These conditions would apply in the Central Mass. market area. Therefore a 40% factor was applied to both the on-line and off-line Central Mass. communities.

The 1990 Census results show a total of 1,663 Boston Proper work trips from Wayland, Sudbury, Hudson, Bolton, Berlin, Marlborough, Clinton, Boylston, and the southern half of Stow. A 40% share of this market would equal 665 trips.

Extension Share of Other Boston and Cambridge Work-Trip Markets at 1990 Travel Levels

Using procedures similar to those used for estimating Boston Proper work trips, it was concluded that a Central Mass. extension could be expected to capture about 15% of the work trips to Boston destinations outside Boston Proper from its market area. The 1990 Census results show a total of 1,465 other Boston work trips from the Central Mass. market area, of which a 15% share would be 220.

At present, the Fitchburg Line is the only MBTA commuter rail line providing direct service to Cambridge. Despite this, it captures smaller shares of Cambridge work trips from its service area than most of the other lines capture from theirs. This is partly because the Fitchburg Line corridor also has much more convenient highway access to Cambridge than do most other corridors. In addition, ridership at many Fitchburg Line stations is constrained by parking capacity. Central Mass. trains would enter Boston over the Fitchburg Line, and residents of its market area also have access to the same highways to Cambridge used by Fitchburg corridor residents. The Fitchburg Line share of Cambridge work trips from most towns in its service area is about 10%. It was assumed that with unlimited parking the Central Mass. would capture 15% of Cambridge work trips from its service area. The 1990 Census results show a total of 950 such trips, of which a 15% share would be 143. (A 15% share would be consistent with results from other North Side lines. A 10% share would be only 48 fewer riders.)

Extension Share of Other Travel Markets

In the preceding sections, the estimated number of work trips to all of Boston and Cambridge that would be captured by a Central Mass. extension totals 1,027. The 1993 survey results show that for the North Side lines as a whole, work trips accounted for 86% of all trips with final destinations in Boston or Cambridge. Applying the same factor to the Central Mass. results in an estimated 164 non-work trips to Boston or Cambridge, or a total of 1,192 trips for all purposes.

The survey results also showed that for the North Side lines as a whole, 92% of all trips for all purposes were destined for Boston or Cambridge, and 8% for other locations. With similar proportions, Central Mass. service would be expected to attract 103 riders with destinations outside Boston or Cambridge. With trip purpose proportions similar to those on other North Side Lines, about 45 of these would be work trips. These would include both interzone trips (that is trips between two stations served directly by Central Mass. trains excluding North Station and Porter Square) and trips passing through Boston or Cambridge.

Much of the interzone travel on the present North Side lines consists of private school and college students. The Central Mass. would be able to serve student travel to Brandeis University from new stations further west, but there are no schools on the Central Mass. itself that would generate ridership. Based on an examination of possible interzone destinations on Central Mass. trains, and of the origin and destination patterns and trip purposes of interzone trips on the Fitchburg Line, it was estimated that Central Mass. trains would carry only about 22 interzone trips per day. Most of these would be destined for points in Waltham or Belmont. Therefore, of the 103 trips to points outside Boston or Cambridge, 80 would be made via Porter or North Station.

Total estimated ridership for the Central Mass. to all destinations for all trip purposes adds up to 1,295.

Ridership Changes from 1990 to 1996 and Future Years

As discussed above, work trips to Boston would account for the largest portion by far of ridership on a Central Mass. commuter rail extension. Therefore, in estimating ridership in future years, it is most important to examine changes in work travel. The most comprehensive information on work trips is that provided by the U.S. Census Journey-to-Work survey. This is conducted in conjunction with the regular decennial Census, so the most recent figures available are from 1990. Some changes in travel patterns would be expected in the six years since these figures were collected, and institution of commuter rail service implies a relatively long-term investment in fixed facilities. Thus, it is important to try to update the 1990 figures both to the present and to various future years.

Adjustment from 1990 to 1996

Between census years, the Census Bureau prepares estimates of population for states, counties, and municipalities at two-year intervals. Town-level figures are based largely on a sampling of information contained in income tax returns. The estimation process takes considerable time to complete. The most recent estimates are for population as of July 1, 1994, and these were released in the fall of 1995. These estimates do not include any journey-to-work information.

The Census population estimates for cities and towns in the Central Mass. service area, further extrapolated to 1996, indicate overall population growth of about 5% in this area since 1990. As a result of economic conditions, however, overall Boston and Cambridge employment was essentially the same in 1996 as in 1990. Since work trips to Boston and Cambridge would be the predominant source of ridership on a Central Mass. extension, it was concluded that forecasts based on 1996 conditions would not differ significantly from those using the 1990 data.

Projected Demand for Year 2020

Of the nine cities and towns assumed to account for most Central Mass. trip origins, Wayland, Sudbury, Hudson, Marlborough, and Bolton are in the Metropolitan Area Planning Council (MAPC) Region. These five accounted for 93% of the Boston and Cambridge work trips from the nine cities and towns combined in 1990. For the same five municipalities, MAPC projects an overall population increase of about 15% between 1990 and 2020. A proportional increase in ridership on the Central Mass. as a whole would raise weekday inbound boardings to 1,490. MAPC's projected employment increase in the City of Boston between 1990 and 2020 is only 5%, however. Unless a disproportionate

share of new jobs in Boston went to Central Mass. area residents, a maximum of about 1,360 riders would be more likely.

Additional Ridership Attracted to Fitchburg Line

As discussed in Chapter 4, diversions to the Central Mass. would free about 140 parking spaces at Fitchburg Line stations where ridership is now severely constrained by parking capacity. These would likely be re-filled by passengers who currently drive to Alewife station or Riverside.

Additional impacts on Fitchburg Line ridership would depend on the operating strategy for Central Mass. trains between the junction of the two routes and North Station. Because of the importance of Porter Square as an alighting stop, all Fitchburg Line and Central Mass. trains would stop there. Brandeis/Roberts, Waltham, Waverley, and Belmont could be served exclusively by Fitchburg Line trains as at present, by all trains on both routes, by some trains on each route, or by Central Mass. trains only. Increasing the number of trains stopping at any of these stations would be expected to attract additional boardings there. Replacing service now provided at these stations by Fitchburg Line trains with service provided by Central Mass. trains would reduce running time for Fitchburg Line trains from stations further west, and would be expected to attract additional ridership to those stations.

Counts taken in 1994 showed a combined total of 552 A.M. peak boardings at Brandeis/Roberts, Waltham, Waverley, Belmont, and Porter. Waltham and Porter were each served by five trains in this time span, and the others by four each. The maximum additional A.M. peak service that would be provided by Central Mass. trains at these stations would be five trips. Based on past service experiments on the Boston system, the elasticity of peak-period commuter rail service to changes in frequency is about 0.2 (i.e. a 100% service increase would result in a 20% ridership increase). Applying this factor to ridership and service levels at each of the five stations, adding five Central Mass. trains would attract about 105 additional peak riders and adding four trains would attract about 85. All but about 10 to 15 of these riders would be diverted from other MBTA services, including Waltham and Riverside express buses and the Red Line.

Off-peak ridership is typically more sensitive than peak ridership to frequency changes, with an elasticity of about 0.5. About 75% of the off-peak inbound ridership at inner stations on the Fitchburg Line consists of the return halves of reverse-commuting trips, however. Changes in the number of these trips would be expected to be most sensitive to changes in the level of outbound A.M. peak service, with the peak elasticity factor applying. For purposes of analysis, a composite elasticity factor of 0.28 was used for off-peak service.

The two levels of off-peak service analyzed in detail for the Central Mass. were 11 trips (the same as current service on the inner end of the Fitchburg Line) or

four trips (the same as the outer end of the Haverhill Line) in each direction. Adding the more frequent service to existing service at the stations on the shared segment would attract about 95 additional off-peak riders. Adding the less frequent service would attract about 40 additional riders. Because of the more limited alternatives in off-peak hours, about 90% of these would be new transit trips.

Under a strategy of replacing rather than supplementing Fitchburg Line service at inner stations with Central Mass. trains, some provision would need to be made for passengers making interzone trips to stations in Waltham or Belmont from points further west on the Fitchburg Line. The 1994 counts showed a combined total of 48 A.M. peak alightings at Brandeis/Roberts, Waltham, Waverley, and Belmont. Half of these (24) were at Brandeis/Roberts. Continuing to stop Fitchburg Line trains there would maintain service for interzone passengers destined there, and would allow passengers for the other three stations to transfer to Central Mass. trains. From stations west of Brandeis/Roberts, running times to Porter and North Station would be reduced by about 4.5 minutes as the result of omitting stops at Waltham, Waverley, and Belmont.

Assuming a travel time elasticity of 0.35 (based on published studies from other cities) a 4.5-minute travel time reduction would have a fairly small impact on Fitchburg Line ridership. With unconstrained parking, a combined total of 50 additional A.M. peak boardings would be expected at stations west of Brandeis/Roberts. Parking is constrained at most of these stations, however. Diversions of riders to stations on a Central Mass. extension would free some parking capacity, but the analysis indicates that these spaces would be re-filled even with no service improvement on the Fitchburg Line. With ridership increases limited to passengers with access modes other than park-and-ride, the increase in A.M. peak boardings at outer stations would be only about 25. (Some of this gain might be offset by losses of interzone passengers for Waltham, Waverley, or Belmont who would be unwilling to transfer at Brandeis/Roberts.)

Under this strategy A.M. peak boardings at Brandeis/Roberts would be expected to increase both because of more frequent service and because of reduced running times to Porter Square and North Station. The overall increase would be about 20 to 25 riders. The increased service frequency at Porter would add about 15 riders there. The combined ridership increase at all stations would be 60 to 65, of which only about 10 would be new transit riders. This compares with 85 to 105 A.M. peak riders (but still only 10 to 15 new transit riders) attracted by having trains from both routes serve all stations in Waltham and Belmont.

Most off-peak Fitchburg Line trains now stop at Waverley and Belmont only on demand, of which there is often none. Therefore, shifting off-peak service at these stations to Central Mass. trains would have little actual impact on travel times for Fitchburg Line trains. Off-peak ridership from stations west of

Waltham to Porter Square or North Station is relatively low (about 300 inbound riders per day in 1993). Elasticity formulas, adjusted for parking constraints, indicate that fewer than 10 additional riders would be attracted at stations west of Waltham during off-peak hours. Most of these would be diverted from other transit services.

As in the A.M. peak, ridership at Brandeis/Roberts and Porter would increase as a result of having both Fitchburg Line and Central Mass. trains stopping there. The combined gain at these stations would range from 30 to 75, depending on the number of Central Mass. trains added. All but about 15 of these would be new transit riders.

APPENDIX F - HISTORY OF CENTRAL MASS. CORRIDOR PUBLIC TRANSPORTATION SERVICE

Previous Rail Passenger Service

Construction of the Central Mass. rail line was started by a company chartered in 1869 as the Massachusetts Central Railroad. This company's line was to have branched from the Fitchburg Railroad (now the MBTA Fitchburg Line) at Stony Brook Station, on the border of Weston and Waltham¹⁷. The Fitchburg Line itself had been completed from Boston to Fitchburg in 1845. A station at the present Kendal Green site was established before 1850.

Service on the Massachusetts Central between Boston and Hudson began in 1881, and was extended west through Berlin and Clinton to Holden in 1882. By the time the first section opened, the Mass. Central was controlled by the Boston & Lowell Railroad interests. Because of this, it was continued east to a connection with the B&L system at North Cambridge (as described in appendix B) rather than connecting with the Fitchburg in Weston.

The Massachusetts Central was reorganized in 1883 as the Central Massachusetts Railroad. The line reached its maximum extent in 1887, when it was completed to Northampton. Passenger trains from Boston were run over the entire line, but schedules suitable for work trips to Boston were generally operated from no further west than Oakdale Station in West Boylston. As the result of corporate mergers and leases, the Central Massachusetts, the Fitchburg and the Boston & Lowell Railroad had all become part of the Boston & Maine Railroad system by 1900. In 1903, in conjunction with a line relocation forced by the construction of the Wachusett Reservoir, the outer terminal for commuter-oriented service on the Central Mass. became Clinton Station on the Boston & Maine's present Worcester Route Main Line. The segment of the Central Mass. line immediately west of Oakdale Station was abandoned in 1939, partly as a result of damage from the 1938 hurricane.

Passenger service on the Central Mass. line peaked about 1903, when there were fourteen round trips per day between Boston and Wayland or points further west. Substantial service cutbacks on the line began during World War I, and continued thereafter. In May 1958, the outer limit of passenger service on the Central Mass. was cut back from Clinton to Hudson, and frequency was reduced to two round trips per day. In October 1958, these trains were re-routed from the Central Mass. to the Marlborough Branch west of Gleason Junction, terminating near Washington Street in Hudson. This service was reduced to a single round trip in June 1959. This configuration lasted until January 1965, when service was cut back to South Sudbury. MBTA subsidization of B&M commuter service

¹⁷This station was at the present crossing of the Fitchburg Line and the Boston Post Road (U.S. Route 20).

began at that time. Sudbury was the outermost town in the MBTA District on the Central Mass. The town of Hudson would have had to contract with the MBTA to retain service, but chose not to because of low ridership.

A 1968 passenger count showed an average of 77 weekday inbound riders a day on the Central Mass. trains. Service to South Sudbury continued until November 1971, when deteriorating track condition, low ridership and budgetary constraints combined to bring an end to all Central Mass. passenger service. An experimental increase of frequency to four round trips per day in the final weeks had failed to attract substantial numbers of additional passengers.

Express Bus Service

Despite the discontinuance of passenger service on the Central Mass. line, there has also been a substantial decrease in the amount of bus service to Boston from most points in the Central Mass. corridor since 1971. This implies that even after population growth, the demand for direct public transportation service from this area to Boston has fallen. Details of experience on individual routes are provided below. Additional information on the routing and ridership of those routes that are still in operation is contained in chapter 2 and appendix A.

Post Road Line

This route runs from Northborough to Boston via Routes 20 and 128 and the Mass. Turnpike. It is the last surviving remnant of a route between Worcester and Boston which was initiated in 1924. Until the early 1970s, service on this route was run on hourly headways throughout the day. Because of declining ridership, service was cut back to four round trips a day in 1973. Additional cutbacks occurred over the next decade. There have also been several changes in operators. Since 1984, only one round trip per day has been run on this route. Funding for this service has been provided through the MBTA/EOTC Interdistrict Transportation Service Program since 1987. Prior to that, the route was unsubsidized.

Hudson-Boston Route

This route was started by Gulbankian Bus Lines in 1988, replacing a route from Southborough to Boston that had been started by the same company in 1981. Gulbankian is still the operator. The level of service has never exceeded the present three round trips per day, provided since about 1990, but there have been some slight adjustments in departure times. Prior to 1994, the only Boston stops on the route were Copley Square and Park Square.

Former Wayland-Natick-Newton Corner Route

A bus route between south Wayland and South Natick via downtown Natick was established in 1925 by the Middlesex and Boston Street Railway Company (M&B) in place of a trolley line. Alternate trips ran from Wayland endpoints on Route 27 at School Street and on Route 126 at Stonebridge Road. Connections to the Framingham commuter rail line were possible at Natick Station. This route was still operating in 1964, when the MBTA began subsidizing M&B service, but had service only in peak hours by then. Passenger counts in 1968 showed only about 40 passengers a day in each direction on this route, with only about 10 boardings in Wayland.

In 1969, the route was substantially restructured. The two separate northern endpoints were replaced by a one-way loop by extending both branches to the southerly junction of routes 27 and 126. The segment from Natick to South Natick was dropped, and buses were run through from Wayland to Newton Corner via state Routes 135 and 16. (Previously a transfer to a separate route at Natick had been needed to accomplish the same trip.) This route connected at Newton Corner with MBTA express bus service to Boston, and at Woodland Station with the Green Line.

In June 1972 M&B went out of business and the MBTA assumed direct operation of most former M&B routes. Service from Wayland to Natick was permanently discontinued in September 1972, however.

Bus Routes Serving Towns Adjoining the Central Mass. Corridor

Littleton-Boston Route

This route was established by Yankee Line in 1986, replacing a route between Fort Devens and Boston that had been discontinued by another carrier the previous year. The present routing, stops, and service level have been in effect since 1991. The earlier route was the successor to one between Boston, Fitchburg and points west that was first established in the 1920s. Service frequency was increased substantially in 1965 as the result of the discontinuance of commuter rail service west of Ayer on the Fitchburg Line. The peak service level on the bus route was reached around 1970, when there were 12 round trips a day. The re-institution of commuter rail service to Fitchburg in 1980 was followed by substantial cutbacks in the bus schedule over the next few years. Service was discontinued west of Fort Devens about 1984.

Shoppers World-Boston Routes

The Route 9 local service, which originates in Worcester, is the older of the two bus routes from Framingham to Boston. It is a successor to a route started in 1932 to replace a trolley line. The Shoppers World express route originated in

1965 as part of a variation of the older Worcester route. Separate short-turn service to Boston from Shoppers World and Edgewater began in 1972.

Discontinued Marlborough-Boston Express Route

In addition to the Post Road and Gulbankian routes, a third express bus route from Marlborough to Boston was operated by Peter Pan Bus Lines experimentally during 1993, but was unsuccessful. It was run as an extension of Peter Pan's Shoppers World Express Route, and served one stop in Marlborough on Route 20. This route had four inbound and six outbound trips per day, including two inbound A.M. peak and two outbound P.M. peak trips. The scheduled time from Marlborough to Copley Square was one hour and five minutes, compared to one hour via the Post Road line.